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MOSQUITO F NEW YORK

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Vith Identification Keys to Culicidae

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ulletin No. 430a

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Cover photo: end view of egg of *Aedes stimulans* (Walker); courtesy of Dr. William R. Horsfall, Professor Emeritus, Department of Entomology, University of Illinois, Urbana, Illinois.

Cover illustration: *Aedes triseriatus* (Say), illustrated by Kathryn M. Conway.

MOSQUITOES OF NEW YORK

Part I. The Genus *Aedes* Meigen
With Identification Keys to Genera of Culicidae

Robert G. Means
Senior Scientist, Entomology

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Bulletin No. 430a
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The University of the State of New York
THE STATE EDUCATION DEPARTMENT
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Albany, New York 12234

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ABSTRACT

This work brings together systematically for the first time since 1904 much information regarding *Aedes* mosquitoes of New York. It is the first of a two-part series; the second volume will deal with the other genera occurring in New York. Keys for the identification of adults; pupae; first instar larvae and second, third and fourth instar larvae of mosquito genera; and the species of *Aedes* occurring in New York are presented. Thirty-one *Aedes* species are reviewed, summarized, keyed and illustrated. Species treatment includes synonymy, descriptions of adults and immature stages, bionomics, distribution, disease relationships and pertinent literature. General information on methods of collecting and preserving, mosquitoes as disease vectors, bionomics and structures used in taxonomic procedures are discussed. Attention is called to the increasing public health importance of *Aedes* mosquitoes as vectors of encephalitis viruses in New York, and the need for more detailed ecological studies of vector species. Three hundred and twenty-three figures are included.

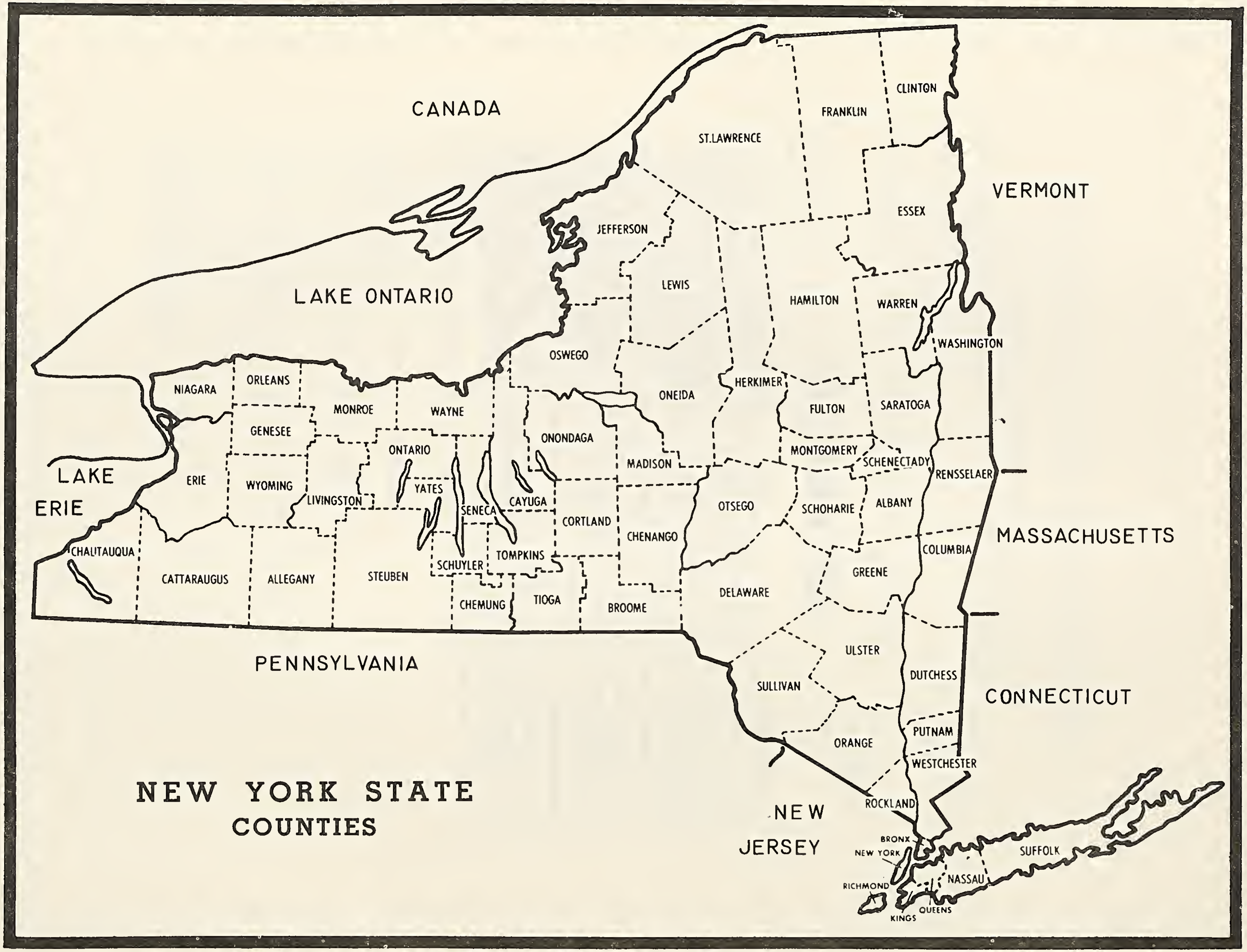

Figure 1. Counties of New York State

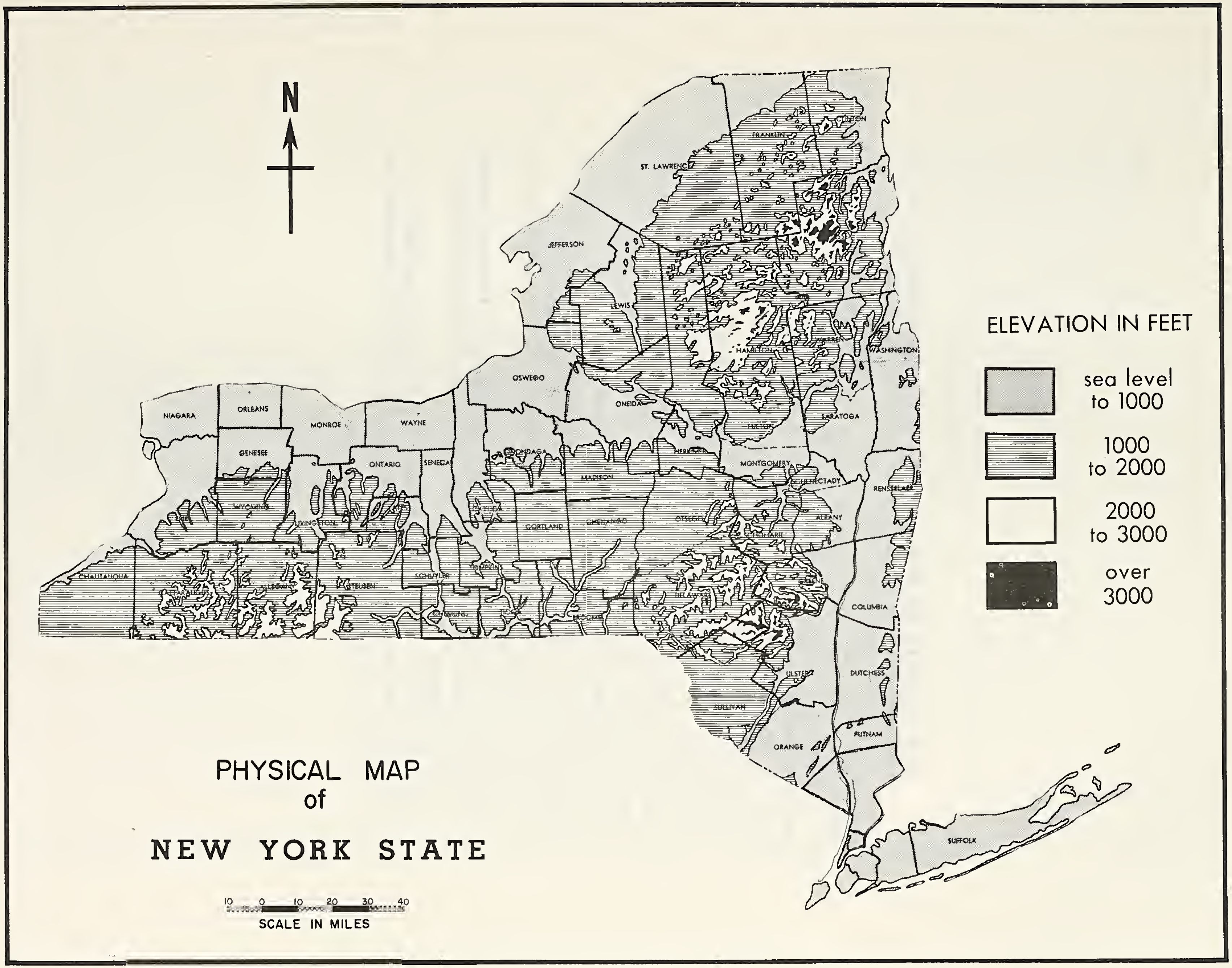

Figure 2. Physical Map of New York State

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MOSQUITOES OF NEW YORK [1]

INTRODUCTION

The family Culicidae is composed of three subfamilies, the Anophelinae, the Toxorhynchitinae and the Culicinae. In the Anophelinae, only the genus *Anopheles* is represented in New York State with seven species. The subfamily Toxorhynchitinae is represented in New York by a nonbiting species, *Toxorhynchites rutilus*. Culicinae is by far the largest subfamily with two tribes containing 27 genera. The tribe Sabethini contains eight genera worldwide, but is represented in New York by only one genus, *Wyeomyia*, with one or possibly two species. The tribe Culicini contains 19 genera, of which seven are represented in New York by 47 species.

Among the earliest papers dealing with mosquitoes in New York were those by Dyar (1902b), Johannsen (1903) and Felt (1904). Johannsen included 22 species in subfamily Culicinae in keys adapted from Dyar (1902a, b; 1903) and included descriptions and discussions of 12 New York species in five genera.

In the Mosquitoes of New York, Felt (1904) listed 25 valid species in the subfamilies Culicinae, Anophelinae and Aedomyinae as occurring in New York. He also included nine valid species from neighboring states.

In an extensive monograph by Howard, Dyar & Knab (1917), distribution records for North American mosquitoes included 33 species from New York. In his Handbook of the Mosquitoes of North America, Matheson (1944) reported 47 species occurring in New York.

An annotated list by Barnes, Fellton & Wilson (1950) included distribution records based on collections made at armed services installations for 51 species in nine genera, including five species not previously reported from the State. One additional name has since been synonymized with another species in the list, and one of the 51 species was listed based on misidentifications, these specimens later found to be a new species described in 1954 (Vockeroth, 1954b).

A list by Jamnback (1969) included 53 species in the family Culicidae, and five additional species have been reported from the State since then (Mullen, 1971; Means & Thompson, 1971; Wallis & Whitman, 1971; Zavortink, 1972; Bell & Benach, 1973), bringing the total of species reported from New York to 58.

Other than the excellent monograph by Carpenter & LaCasse (1955) which deals with the mosquito fauna of North America north of Mexico, there is no single source of taxonomic and bionomic information on the mosquitoes of northeastern United States. The purpose of this paper is to provide such information for species which occur in New York. Several species occurring in adjacent states and southeastern Canada, which may occur in New York, are also included.

Part I includes keys for identification of genera of all stages (except eggs) of the family Culicidae, a comprehensive treatment of the genus *Aedes* and a systematic list of the species of mosquitoes reported from New York. Keys to species, brief synopses, bionomics, distribution and importance (medically and as pest species) are included for the genus *Aedes*. Synonymy and taxonomic references are given as they apply to New York taxa; e.g., a species described from Karner, New York and later found to be synonymous with a species described earlier is included in the list of synonyms, but a species described from South America and later found to be synonymous with a species occurring in New York is not included unless this name was mentioned in an earlier listing of the mosquitoes of New York.

Part II will include keys to species and a similar taxonomic and bionomic treatment for other genera occurring in New York. Also included will be a discussion of recommended control procedures, including the potential use of biological control agents.

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MOSQUITOES AND DISEASE

In New York State, as in most parts of the world, mosquitoes have long been a subject of great concern. Malaria and yellow fever are no longer prevalent in New York; however, mosquito-transmitted arboviruses, especially Eastern Encephalitis, California Encephalitis and Dog Heartworm (filariasis), present a constant threat to the health of residents and domestic animals. In addition to the obvious importance of disease-transmitting mosquitoes, pest species affect the economy of the State, especially in areas which depend on tourism for revenue. Bradley (1951), in quoting the Surgeon General, described public health as "Physical efficacy and comfort . . . which may be seriously disturbed by the continued annoyance of pestiferous mosquitoes which may or may not have disease transmitting potentialities."

MALARIA. Malaria is basically a tropical disease. However, until the beginning of the 20th century, one type, benign tertian (caused by *Plasmodium vivax*), was common throughout the temperate region and was recognized as a factor in the colonization of the Atlantic coastal states (Herms & James, 1961). As recently as the 1930's, there were 6 to 7 million cases annually in the continental United States (Russell, 1959), but it has now largely disappeared, the last series of endemic cases in New York occurring in 1922 (Jamnback, 1969).

Human malaria is transmitted by anopheline mosquitoes, the principal vector in eastern United States being *Anopheles quadrimaculatus*. Since *A. quadrimaculatus* is essentially a suburban or rural mosquito, the decline of malaria has been attributed, at least partly, to increased industrialization and a corresponding decrease in the rural farm population, resulting in reduction of transmission to a point where the cycle was interrupted and the disease disappeared. However, *A. quadrimaculatus* is widespread and is still able to transmit the disease locally from persons returning to the State who have acquired infections elsewhere. Two such cases were reported from Nassau County in 1943, and another in 1966, all in the vicinity of hospitals where some of the patients had malaria infections.

Benign tertian malaria is usually not fatal and normally disappears within 2 to 5 years. It is the only type of malaria which is adapted to temperate climates; however, other severe types may occasionally be transmitted if suitable conditions exist. The most recent occurrence was at a children's camp in southwestern New York in 1972, involving transmission of *falciparum* malaria (a severe form caused by *Plasmodium falciparum*), presumably by *Anopheles quadrimaculatus*, from a counselor who had come to New York from the Ivory Coast to another counselor (Benach *et al.*, 1972).

Although mammalian malaria is uncommon in temperate climates, avian malaria is prevalent (Bennett & Fallis, 1960). Some birds are almost universally infected; however, the effects of parasitism on the hosts are not known (Russell *et al.*, 1963). Unlike mammalian malaria, which is transmitted by anopheline mosquitoes, the plasmodia causing bird malaria are usually transmitted by species of *Culex* and *Aedes* (Herms & James, 1961).

ARBOVIRUSES. James & Harwood (1969) state, "Arthropod-borne viruses (abbreviated form is *arboviruses*) are causal agents of some of the most serious and widespread diseases of man and animals." Further, "Mosquitoes are carriers of more of these viruses than any other group of vectors." Several outbreaks of mosquito-borne arboviruses have occurred in the United States since 1933 when Eastern Encephalitis was first identified by Ten Broeck & Merrill, and earlier epizootics were probably caused by the same virus (Beadle, 1962; 1959; Hanson, 1957; Vector Control Briefs, 1965).

In a review of arboviral activity in the United States from 1955 to 1971, McGowan *et al.* (1973) reported that there were more than 3,700 diagnosed cases with 260 deaths associated with St. Louis Encephalitis (SLE), Western Encephalitis (WE), California Encephalitis (CEV) and Eastern Encephalitis (EE). Eastern Encephalitis, which is most common along the Atlantic Coast, is the most virulent of these viruses and accounted for 58 of the 260 reported deaths. About 60 percent of the human cases of EE are fatal and survivors usually suffer mental incapacities (Beadle, 1959; Horsfall, 1962; McGowan *et al.*, 1973). "Epidemics" in Massachusetts were fatal to 25 of 34 victims and 10 of 13 victims in 1938 and 1956, respectively (Alexander & Murray, 1958; Getting, 1941). An outbreak in New Jersey in 1959 resulted in 22 mortalities of the 33 reported cases (Kandle, 1960).

In addition to the medical importance of these diseases, tourist areas suffer great financial losses as a result of adverse publicity concerning the epidemics. Hotels in Atlantic City lost an estimated $2,000,000 in tourist trade and the Garden State Parkway about $60,000 in tolls as a result of the 1959 outbreak (Beadle, 1960).

In New York, EE virus was first isolated from pheasants in 1952 and 1953 (Beaudette *et al.*, 1954), and was again discovered in pheasants and White Pekin ducklings during an outbreak on Long Island in 1959 (Dougherty & Price, 1960). More recently, there have been at least one human case in 1971 (Morris *et al.*, 1973) and several horse fatalities attributed to EE on Long Island and in the central part of the State in 1971 and 1974 (Thomas Bast, New York State Health Department, pers. comm., 1975).

Culiseta melanura, a mosquito which breeds in cold, acid sphagnum bogs, has been incriminated as a major enzootic vector of EE for several years, but because it feeds primarily on birds it may not be important in the transmission to mammals (Goldfield *et al.*, 1968; Jamnback, 1969; Means, 1968). At least 16 species of mosquitoes are known to be potential vectors of EE virus (Chamberlain, *et al.*, 1958; Collins, 1960; Hayes, 1961b; Hayes *et al.*, 1960; Hayes *et al.*, 1962; Howitt, *et al.*, 1949; Karstad *et al.*, 1957; Wallis, 1959; Wallis *et al.*, 1960). Of these, the following species occurring in New York have been found naturally infected: *Aedes mitchellae, A. sollicitans, A. sticticus, A. vexans, Anopheles crucians, An. punctipennis, Culex pipiens, C. restuans, C. salinarius, C. territans, Culiseta melanura, Coquillettidia perturbans* and *Psorophora confinnis* (Goldfield *et al.*, 1968; Jamnback, 1969; Kandle, 1967; Margaret Grayson, New York State Health Department, pers. comm., 1975).

California Encephalitis virus (CEV) was first isolated from mosquitoes in 1943 and 1944 and subsequently described as a new etiological agent (Hammon & Reeves, 1952; Hammon *et al.*, 1952; Reeves & Hammon, 1952). This virus was later found to be composed of several strains, classified collectively as California (CAL) Group, containing at least 10 to 12 closely related viruses (Sudia *et al.*, 1971; Whitman & Shope, 1962). The first recognized epidemic of this virus occurred in 1964 in children in Indiana with additional recognized cases in other states (Marshall, 1965; Beadle, 1966). James & Harwood (1969) state that "this disease now rates second only to St. Louis Encephalitis in causing cases of insect-transmitted encephalitis in the United States in the last few years."

In New York, the disease was first diagnosed from a 23-month-old infant from Rockland County in 1966 and from the mosquito, *Aedes cinereus*, in 1965 (Whitney *et al.*, 1969). There has been a dramatic increase in the number of diagnosed human cases in the last 3–4 years from several areas in the State, mostly in young adults and children, and the sera of many adults have been found to contain antibodies, indicating a higher percentage of transmission than is indicated by the number of clinical cases. Although the disease often produces relatively mild symptoms in adults, it can cause serious infection and even death in children (Margaret Grayson, New York State Health Department, pers. comm., 1975).

The CAL Group viruses are somewhat different from other mosquito-transmitted arboviruses in that many of the vectors are univoltine species which emerge from temporary pools in early spring, whereas EE, SLE, WE and others are transmitted primarily by multivoltine species (Jamnback, 1969). The following mosquito species have been found naturally infected with CAL Group viruses in New York: *Aedes aurifer, A. canadensis, A. cantator, A. cinereus, A. communis, A. stimulans, A. triseriatus, A. vexans* and *Coquillettidia perturbans* (Margaret Grayson, New York State Health Department, pers. comm., 1975; Whitney *et al.*, 1969). The virus has also been isolated from 18 species which occur in New York (Sudia *et al.*, 1971). It is generally believed that birds are the main reservoirs for EE, WE and SLE (Beadle, 1959), and cold-blooded animals may serve as overwintering reservoirs (Thomas & Eklund, 1960; Thomas *et al.*, 1958). However, recent evidence has shown that small, forest-dwelling mammals may serve as summer reservoirs of La Crosse, a CAL Group virus (Moulton & Thompson, 1971; Pantuwatana *et al.*, 1972) and there may be transovarian transmission and overwintering in the eggs of *Aedes triseriatus* mosquitoes (Pantuwatana *et al.*, 1974; Watts *et al.*, 1973; Watts *et al.*, 1974).

There have been no confirmed human cases of SLE or WE in New York although there is serologic evidence that they are not uncommon in the State (Jamnback *et al.*, 1965; Whitney, 1963). In addition, antibodies to Cache Valley Virus (CV) have been found in the sera of more than 20 percent of the dairy cows in northern New York (Whitney, 1965), and the virus has been isolated from *Culex pipiens* group mosquitoes in Albany (Margaret Grayson, pers. comm., 1975). The first isolations of Flanders virus (FLA) were made from mosquitoes *(Culiseta melanura* and *Culex pipiens)* and an ovenbird from Long Island (Whitney, 1964). Flanders virus has subsequently been isolated from the following mosquitoes which are reported from New York: *Aedes atlanticus, A. triseriatus, A. vexans* and *Culex restuans* (Jamnback, 1969).

Another mosquito-transmitted viral disease, yellow fever, is essentially tropical; however, epidemics occurred in New York in the 18th and 19th centuries. The principal vector, *Aedes aegypti*, has occasionally been reported from New York State and other northeastern states (Chandler, 1945; Bell & Benach, 1973), but its occurrence has never been permanent in these latitudes which are north of its normal range (Christophers, 1960). Bell & Benach concluded that the most recent infestation in 1972 resulted from accidental introduction of eggs or adults by train or car from infested areas in the southern United States or abroad.

The epidemics of colonial years (Duffy, 1953) were probably caused by transmission of the virus by local infestations of *aegypti* which were introduced by wooden sailing vessels. These ships, as well as water storage cisterns and rain barrels, provided protected breeding places, allowing large populations of the mosquito to build up during the summer. Suitable breeding habitats were greatly reduced with the introduction of community water systems and modern metal steamships, thereby eliminating local transmission of the virus during the last century (Chandler, 1945).

FILARIASIS. Mosquitoes are also known to transmit filarial worms which cause enlargement of appendages and reproductive organs (elephantiasis) to man in the tropical and subtropical regions of the world, but this disease is not likely to become established in temperate climates.

However, filarial parasites are common in many species of birds, mammals and frogs in temperate climates (King *et al.*, 1960; Bennett & Fallis, 1960; Causey, 1939). Little is known of the biology of most of these parasites, but some are transmitted by mosquitoes.

The most important filarial parasite in the Northeast is heartworm, *Dirofilaria immitis*, which infests dogs and, occasionally, cats. Until recently, this parasite was found only occasionally in New York, but up to 90 percent of the dogs were infected in some parts of New Jersey (Crans, 1963). In the last 5 years, heartworm has become a major concern to dog owners throughout New York, Massachusetts, New Hampshire and other northeastern states. A recent survey indicated that 5 percent of the dogs in central New York in the vicinity of Syracuse were infected (C. D. Morris, New York State Health Department, pers. comm., 1975).

At least 24 species of mosquitoes in New York are potential vectors of *D. immitis* (Ludlam, 1970; Seeley & Bickley, 1974). Of these, *Culex* species are considered relatively poor carriers; several *Aedes* species, especially *A. sollicitans* and *A. triseriatus*, are better carriers; and *Anopheles* species are the best carriers (Yen, 1938; Intermill, 1973).

BIOLOGY OF MOSQUITOES

Mosquitoes are aquatic in their immature stages, developing in a wide range of habitats. Several systems of classifying mosquitoes into different groups have been used, the most useful for North American mosquitoes being that of Pratt (1959). This method of grouping provides 11 basic categories based on the stage in which the species overwinters, the place and manner in which eggs are laid and the number of generations per year. Although some species fall into more than one type depending on the climate, only types I–VII as listed here are exhibited in New York:

I. *Culex pipiens* Type
  1. Overwinter as adults (either fertilized or autogenous females)
  2. Eggs laid in rafts on water surface
  3. Multivoltine (several generations per year)

II. Northern *Aedes* Type
  1. Overwinter as eggs
  2. Eggs laid singly on damp earth or mud
  3. Univoltine (one generation per year)

III. Temporary pool *Aedes* and *Psorophora* Type
  1. Overwinter as eggs
  2. Eggs laid singly on damp earth or mud or on the edge of a "container"
  3. Multivoltine
     This includes several groups:
     A. Salt marsh group
     B. Temporary pool or "floodwater" group
     C. Artificial container group
     D. Treehole group
     E. Rockpool group

IV. *Coquillettidia* (formerly *Mansonia*) *perturbans* Type
  1. Overwinter as larvae
  2. Eggs laid on water surface
  3. One irregular generation per year

V. *Anopheles walkeri* Type
  1. Overwinter as eggs
  2. Eggs laid on water surface
  3. Multivoltine

VI. *Culiseta melanura* Type
  1. Overwinter as larvae
  2. Eggs laid on water surface
  3. Multivoltine

VII. *Wyeomyia smithii* Type
  1. Overwintering as larvae, often frozen in ice
  2. Eggs laid on inner surface of water-holding leaves
  3. Multivoltine

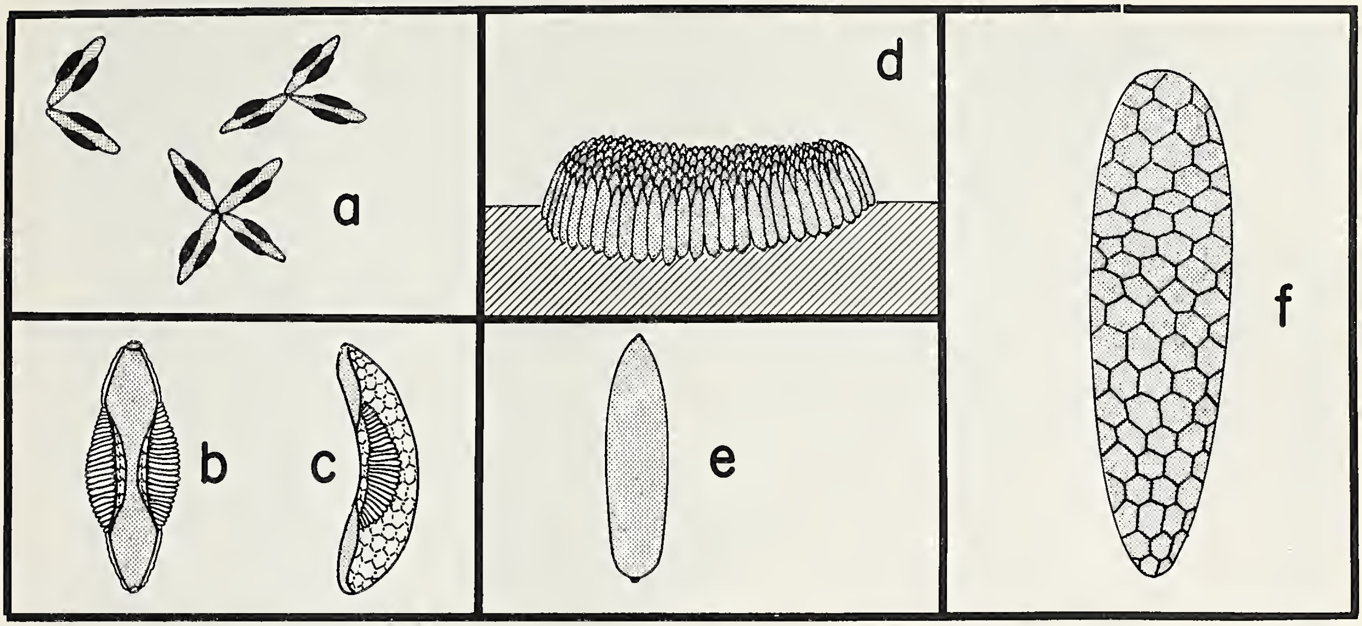

Figure 3. Mosquito eggs: a.-c. *Anopheles* sp.: a. clusters on water surface, b. dorsal aspect, c. lateral aspect, d.-e. *Culex* sp.: d. raft on water surface, e. individual egg, f. *Aedes triseriatus*

Eggs of different types of mosquitoes are deposited in a variety of ways: singly on the water surface (fig. 3a); on the water surface standing vertically in "rafts" of 10 or 12 to several hundred (fig. 3b); singly on the moist edge of a natural or artificial water container, just above the water level; or singly on damp earth, dead leaves or vegetation, in depressions subject to future flooding (fig. 3c). Eggs of univoltine species which overwinter in the egg stage normally require several weeks of low-temperature conditioning before hatching (Gerberg, 1970). Eggs of floodwater species (*A. sticticus* and *A. vexans*) and the rockpool species (*A. atropalpus*) require a reduction in dissolved oxygen, caused by decay of organic matter, before hatching (Gerberg, 1970; Gjullin *et al.*, 1941), thus assuring the newly hatched larvae of a food supply.

Larvae are found in a variety of aquatic habitats and normally require some form of free water to develop. However, it has been noted by others (Barr, 1958; Richards, 1938; Smith, 1904a) and the author has observed that larvae of some species (e.g., *Aedes canadensis, A. communis* and *A. sollicitans)* may develop from the fourth instar to the pupal stage and subsequently to the adult stage in mud alone. Larvae of *A. triseriatus* have been collected from treeholes containing only mud and/or damp leaves, most of the water having evaporated, and, after being placed in water, have developed normally.

Larvae of New York species are known to develop in water ranging from clear, fresh, mountain stream edges and springs to extremely polluted sewerage plants, septic tanks and farmyards; and to saline salt marsh and runoff from salt mines in the central part of the State or brackish pools along the major roadways. Some species breed in both pure and polluted water; others in both fresh and saline water.

The larvae of some species occur in water-filled cavities in a tree (treehole) and in artificial containers such as discarded tires, rain barrels, tin cans, jars, or cemetery vases. Treeholes are usually formed when a limb dies or is cut off and the exposed surface rots as a result of precipitation running over it, thereby forming a cavity in the center of the tree. Other forms of treeholes result from precipitation collecting in a crotch where two or more limbs form an acute angle, from precipitation running into a hole gnawed by a bird or small mammal, or by other means. Most treeholes which hold water obtain the water by precipitation running into them but some are filled with fluids from the tree itself, independent of precipitation (Zavortink, 1968).

The larvae and pupae of *Coquillettidia perturbans* attach to aquatic vegetation, and those of *Wyeomyia smithii* are found exclusively in the water-holding leaves of the pitcher plant, *Sarracinea* spp. (fig. 12).

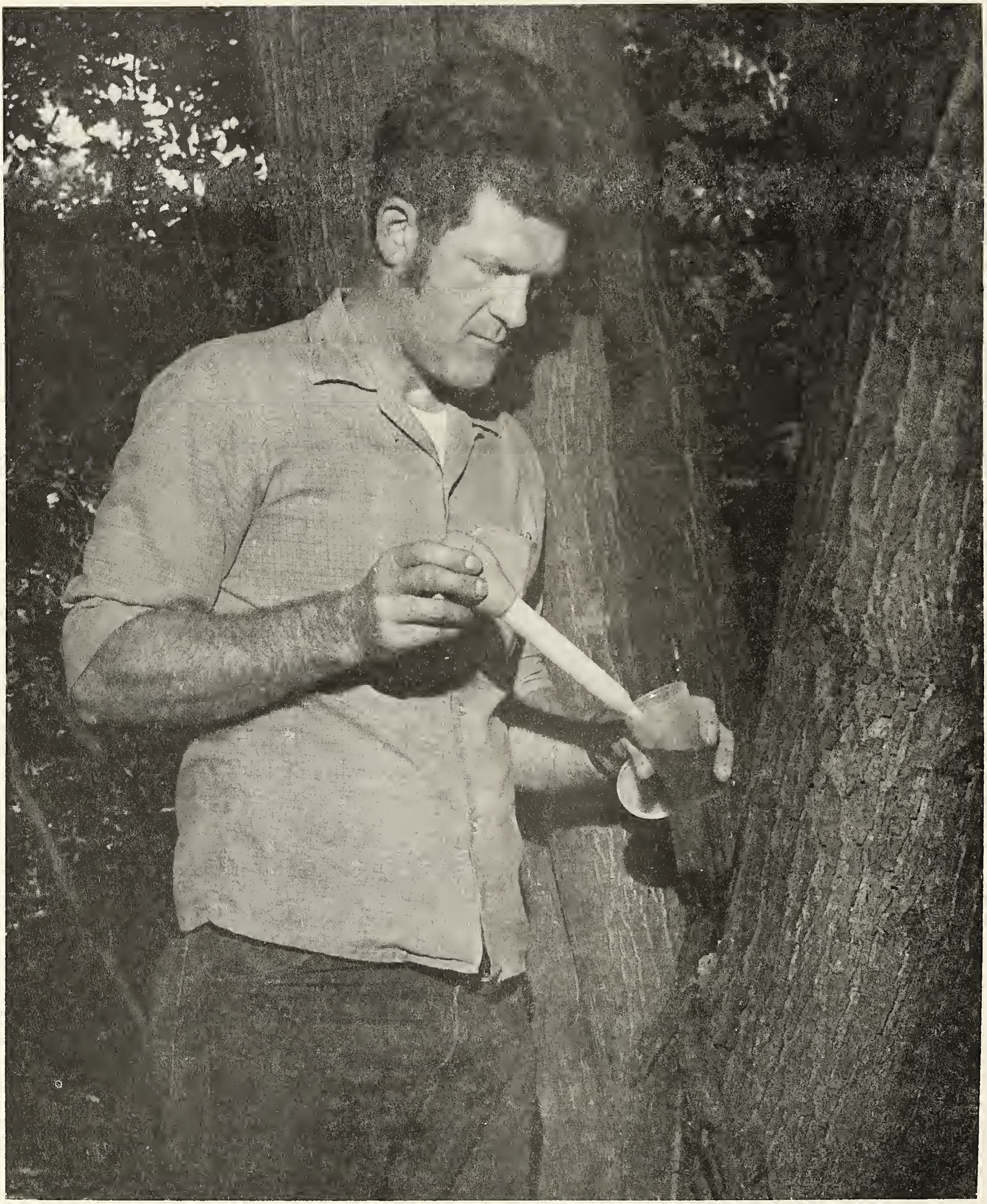

Figure 4. Collecting mosquito larvae from a treehole

COLLECTION AND PRESERVATION

COLLECTING EQUIPMENT—Various pieces of equipment are used for collecting mosquitoes. Some of the most commonly used are included here, but equipment may vary depending on the particular circumstances, and this list is not meant to be complete for all types of collecting.

Dipper: A white enamel water dipper with a capacity of 8 ounces (237 ml) is usually used for collecting mosquitoes from the surface of ponds or pools. Although dippers other than white (i.e., stainless steel) can be used for large larvae, small first instar larvae are difficult to see except against a white background. A dowel or small branch about 3 feet long can be inserted into the hollow handle of most dippers as an extension (fig. 10a).

Bulb syringe: A glass syringe about 8–10 inches long equipped with a large rubber bulb is often used for transferring larvae from a dipper to a container. If the opening on the syringe is smaller than about ⅛ inch (3 mm) the tip should be cut and the end fire-polished to reduce danger of injury to or loss of setae from larvae. Large polyethylene syringes such as those used in cooking may also be used, especially for withdrawing water from a plant leaf axil, treehole or other water-holding container (fig. 4).

Aspirator: A satisfactory and convenient aspirator, or suction tube, for collecting adult mosquitoes in landing/biting collections, from a net or from resting sites can be made from a length of rubber or latex tubing about 10–12 mm OD and about 18 inches long fitted internally at each end with a length of plastic or glass tubing about 6 inches long. One of the pieces of glass tubing should have the end which is inserted in the latex tubing covered with fine mesh organdy or nylon. For collecting several specimens from one location (e.g., from a resting box) a battery-powered aspirator (Carver, 1967) or mouth-operated aspirator containing an enlarged collection chamber (Coluzzi & Petrarca, 1973) is useful.

Collecting jar: Several types of collecting jars are useful for different purposes. If many larvae or pupae are to be collected from a single location and kept alive for more than a few hours, pint- or quart-sized mason jars are useful, although their large size prohibits the collector from carrying more than six or eight for any distance. For most short collecting trips, when the specimens will be killed or isolated within a few hours, small glass or plastic storage jars, which hold 3½ to 4 ounces (approximately 100 ml) of water, with screw caps are quite useful. About two dozen of these can be carried in a canvas collecting bag.

The type of jar most often used by the author is an 8-ounce, polypropylene, stackable container with a tight-fitting snap cover. These are light-weight and take up very little room when empty; therefore, several dozen can be carried into the field in a single collecting bag and as many used as are necessary. By punching a ¼-inch hole in the lid (with a paper punch) and covering it with tape, the same type of container can be used for holding adult mosquitoes collected with an aspirator in landing/biting collections (figs. 4, 8).

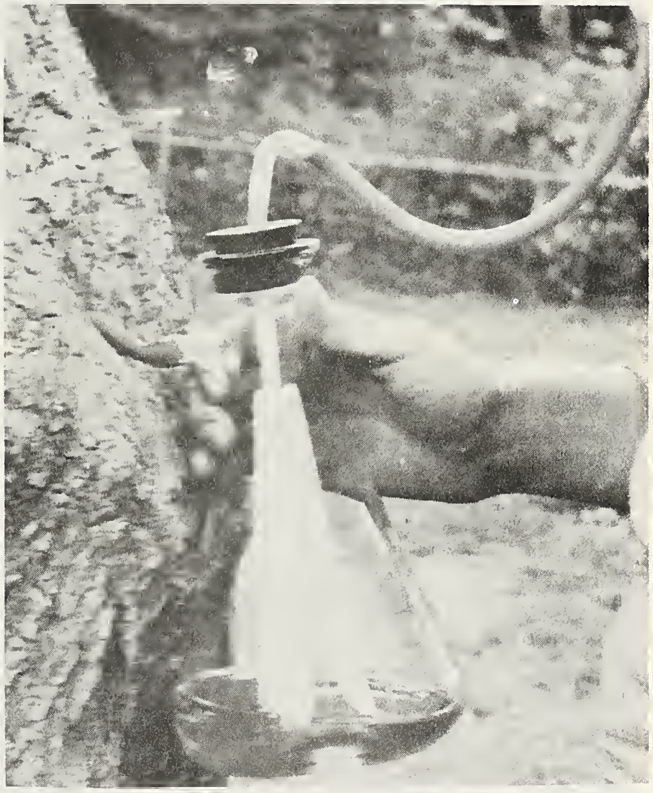

Figure 5. Siphon flask for collecting mosquito larvae from small pools, treeholes and containers

Water collecting flask: For emptying water-holding containers such as treeholes and small artificial containers, a 1-liter erlenmeyer filtering flask, having a side tubulation and a one-hole stopper, is fitted with two 18- to 24-inch lengths of rubber or latex tubing. By drawing on one tube, the water and larvae can be emptied from the container into the flask (fig. 5).

Aerial net: Any kind of aerial net may be used for the collection of adult mosquitoes, but it should be equipped with a fine mesh nylon bag. The author has found both 8-inch and 15-inch collapsible aluminum nets very handy.

Light trap: Two types of light traps for collecting adult mosquitoes are commonly used: the standard New Jersey trap (fig. 6b) which is manufactured to operate on either 110 volts AC current or from a 6- or 12-volt battery, and the CDC miniature trap (fig. 6a) which operates from a 6-volt motorcycle battery or flashlight batteries. Although larger catches are possible with the standard New Jersey trap, specimens are usually in better condition when collected in the CDC trap which uses a less powerful fan. The addition of carbon dioxide, either from a cylinder or from dry ice, greatly increases the mosquito catch in light traps without increasing the number of large insects which injure the mosquitoes. The author has found it convenient and effective to suspend a covered, 1-quart cardboard ice cream container filled with dry ice next to a CDC trap so that it hangs just below the roof of the trap. The carbon dioxide which is emitted through the wall of the container attracts mosquitoes and often increases catches tenfold or more.

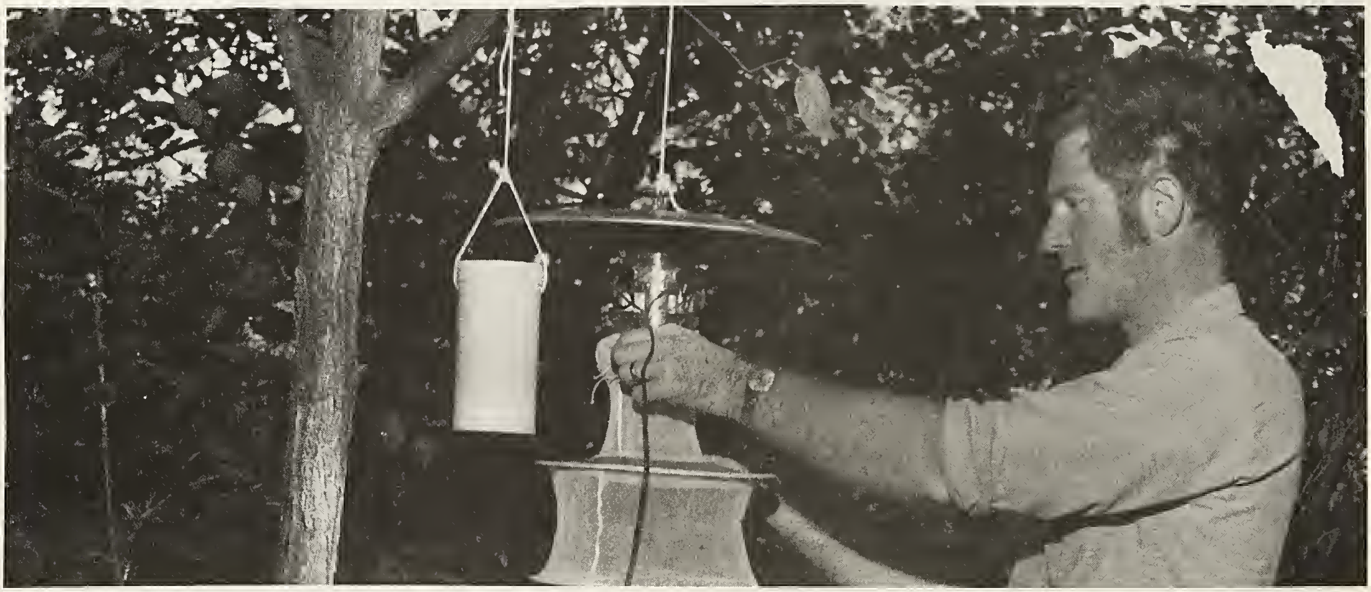

Figure 6. a. Battery-operated CDC light trap for sampling adult populations of mosquitoes

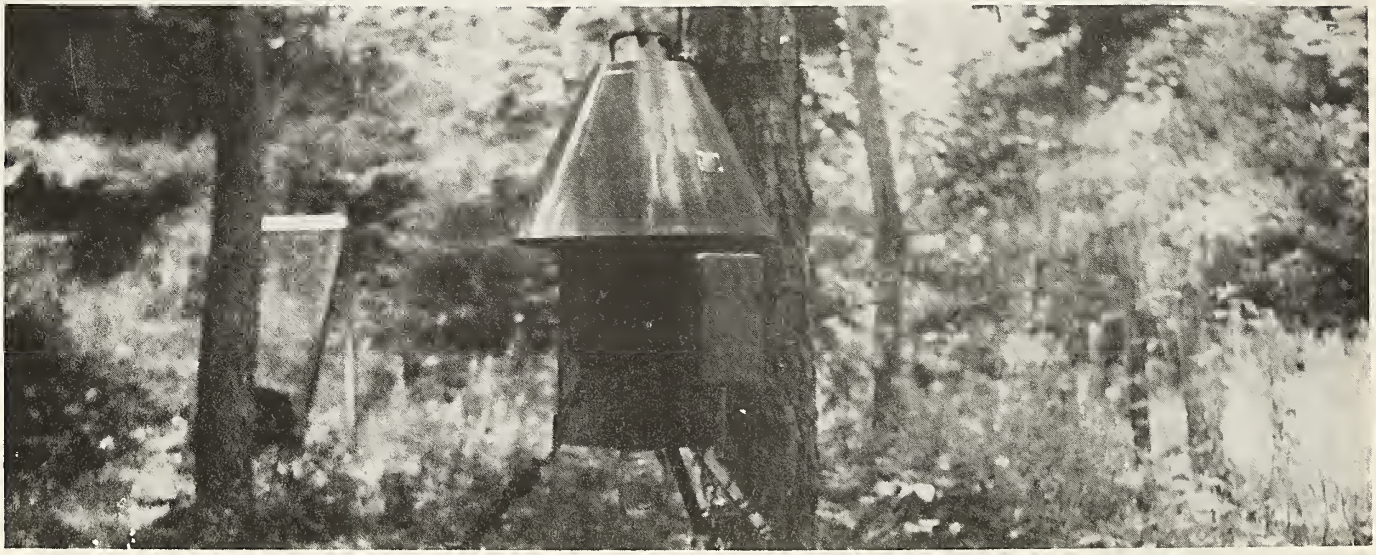

Figure 6. b. New Jersey light trap used for sampling adult populations of mosquitoes

Collecting bag: A heavy canvas duck bag with a shoulder strap is normally used for carrying small collecting equipment. Equipment kept in the bag should include a thermometer, fine point tweezers, a field notebook, pressure-sensitive labels, pen, pencil, label strips for using inside vials, flashlight, trowel, tissue, bulb syringe, collecting cups, aspirator, vials, stoppers (fig. 7).

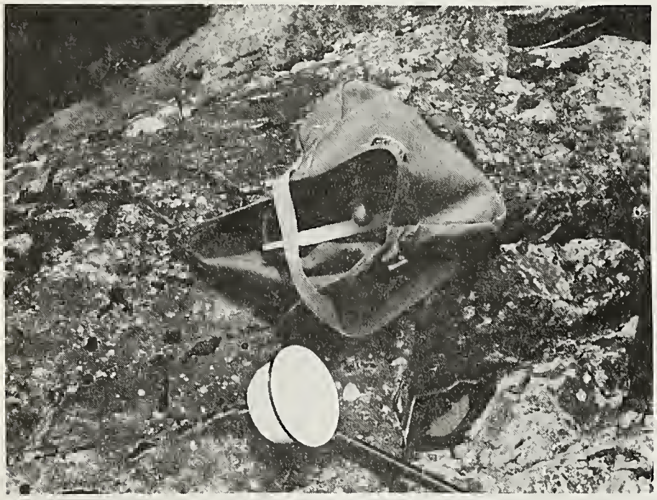

Figure 7. Canvas field bag and white enamel dipper used for sampling mosquito larval populations

Carrying tray: A two- or three-compartment polyethylene tray with carrying handle is useful to carry small equipment into the field (fig. 8).

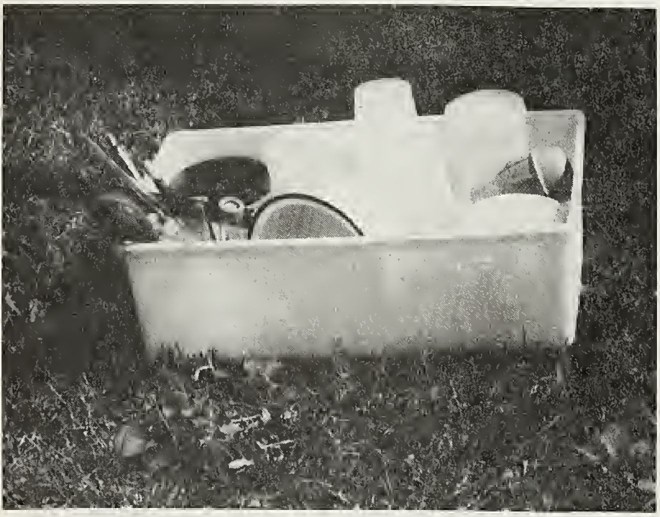

Figure 8. Carrying tray for transporting field collecting equipment

Resting box: Many species of mosquitoes rest during the day in protected places such as hollow trees, caves and culverts. Often they will rest as readily in an artificial "resting box," a 1-foot cube, open on one side, constructed of ½-inch plywood or other suitable material and painted with flat exterior paint. Since some species prefer dark red and others prefer black surfaces, resting boxes of these two colors are both useful (fig. 9).

Figure 9. Artificial resting box for collecting adult mosquitoes

COLLECTING AQUATIC STAGES—The larvae and pupae of most mosquitoes occurring in New York are found in pools of standing water and are most easily collected by skimming the water surface with a dipper (fig. 10). For this method of collecting, a white enamel dipper of 6- to 8-ounce capacity with a 3- to 4-foot handle attached is most useful. The larvae and pupae thus collected are transferred, either by selectively removing them with a large bulb syringe or by pouring them with water, into vials of preservative or collecting jars. Larvae can usually be made to congregate in the lower corner of the dipper by tapping the opposite upper edge of the dipper with a hard object, then most of the water can be gently poured off before transferring the larvae.

When sampling pools in the summer, the collector should approach the pool quietly so as not to disturb the water more than is necessary, because larvae of some species are quite sensitive to foreign movement and secrete themselves under bottom debris. Larvae of *Aedes excrucians*, *A. dorsalis* and other species have been observed to remain under leaves and mud for 15 minutes or more. When larvae or pupae are suspected of being hidden under bottom debris, transfer some of the leaves and/or mud with a dipper to a large shallow tray or bucket, add some clean water if necessary, remove the leaves, and as the larvae or pupae become visible transfer them with a large syringe to a collecting jar.

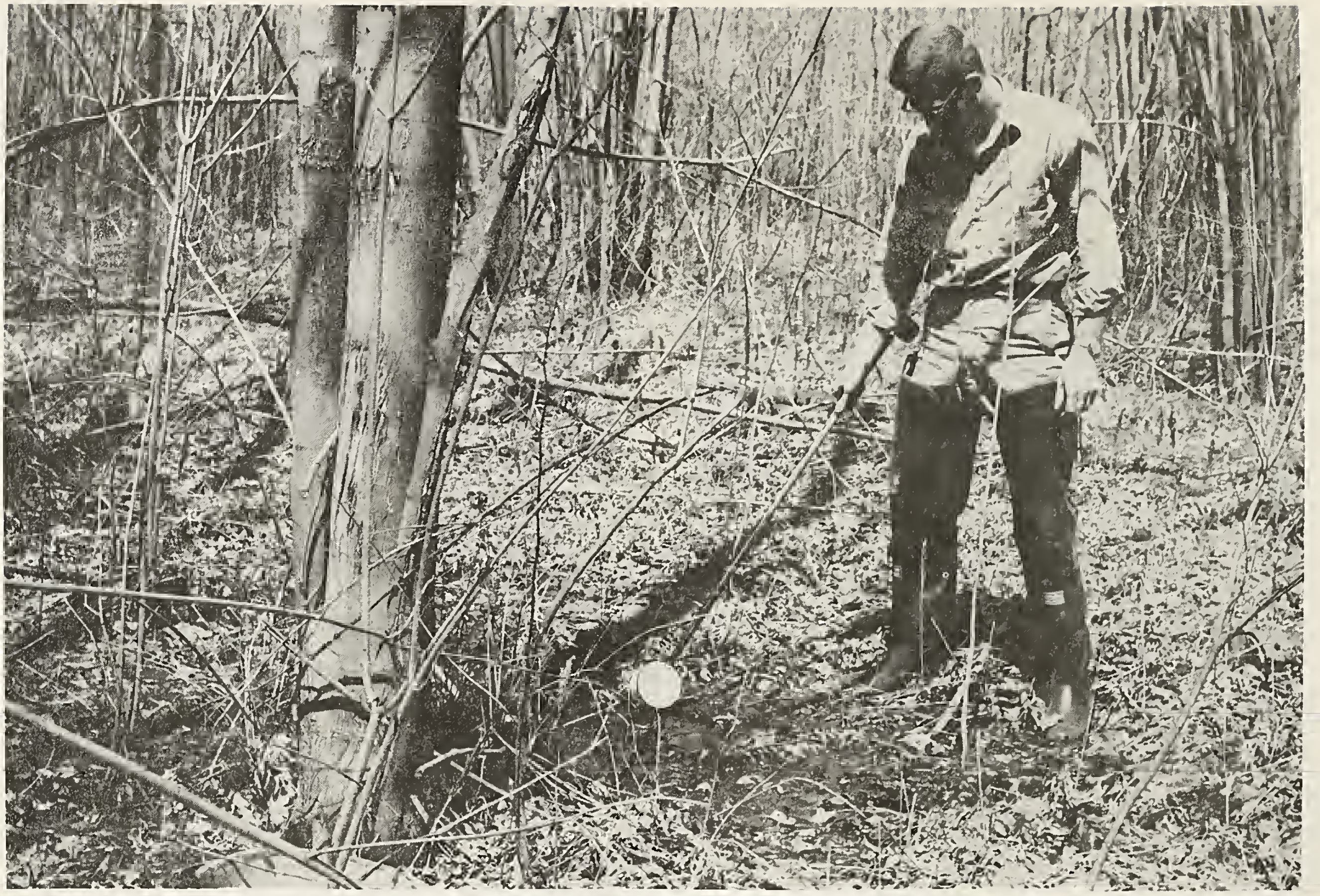

Figure 10. a. Dipping to sample mosquito larval populations

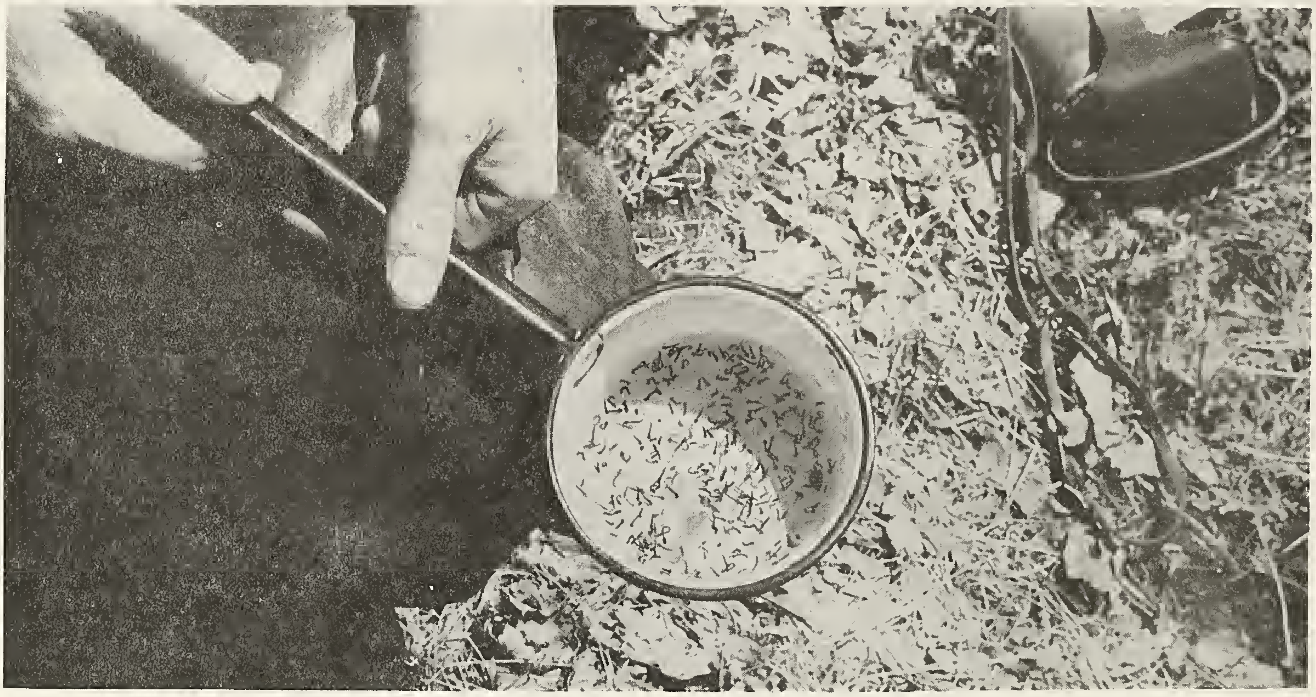

Figure 10. b. Mosquito larvae in white enamel dipper

Larvae and pupae are also found in a variety of other habitats which require certain special collecting techniques. Larvae of *Anopheles* and sometimes *Culex* species are often found at the edge of a running brook or behind blockages in a stream. To collect them from such deep water habitats it is sometimes most efficient to collect a bucketful of water, then transfer the larvae from the bucket to a jar with a bulb syringe. Often the best way to collect larvae from a rockpool or a treehole is to siphon the water into a bucket or collecting jar, then transfer the larvae to another jar with a syringe. The water often evaporates from treeholes or artificial containers, leaving a small amount of water and mud, in which case it is worthwhile to add more water before siphoning. For large rockpools or treeholes, a plastic or latex tube with a bulb in the middle, such as is used for siphoning gasoline, is efficient. For small amounts of water, a siphon-collecting jar made from a filtering flask fitted with tubing (fig. 5) or a piece of translucent or transparent tubing with a large rubber bulb attached (fig. 11) is usually adequate.

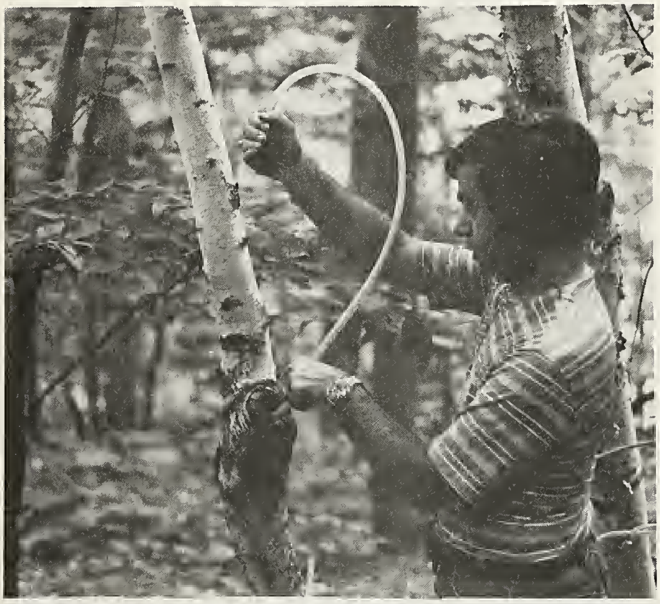

Figure 11. Collecting mosquito larvae from a treehole

Wyeomyia larvae can be collected from a pitcher plant leaf (fig. 12) by bending the leaf to the ground and pouring the water into a collecting jar. However, the larvae sometimes stick to the leaf surface, and it is usually more efficient to remove the leaf from the plant, agitate it, then dump the water into a jar.

Larvae of some species (e.g., *Culiseta melanura*, *Culex territans*, and others) sometimes breed under tree roots in sphagnum bogs accessible only by small openings in the moss. One way to collect from such habitats is to thrust a long-handled dipper through the hole, collect as much water as possible, empty the contents into a pail and after the mud has settled, remove the larvae with a large bulb syringe. Sometimes it is possible to enlarge small holes with a shovel, let the resulting mud settle for a few minutes, then proceed to dip for larvae.

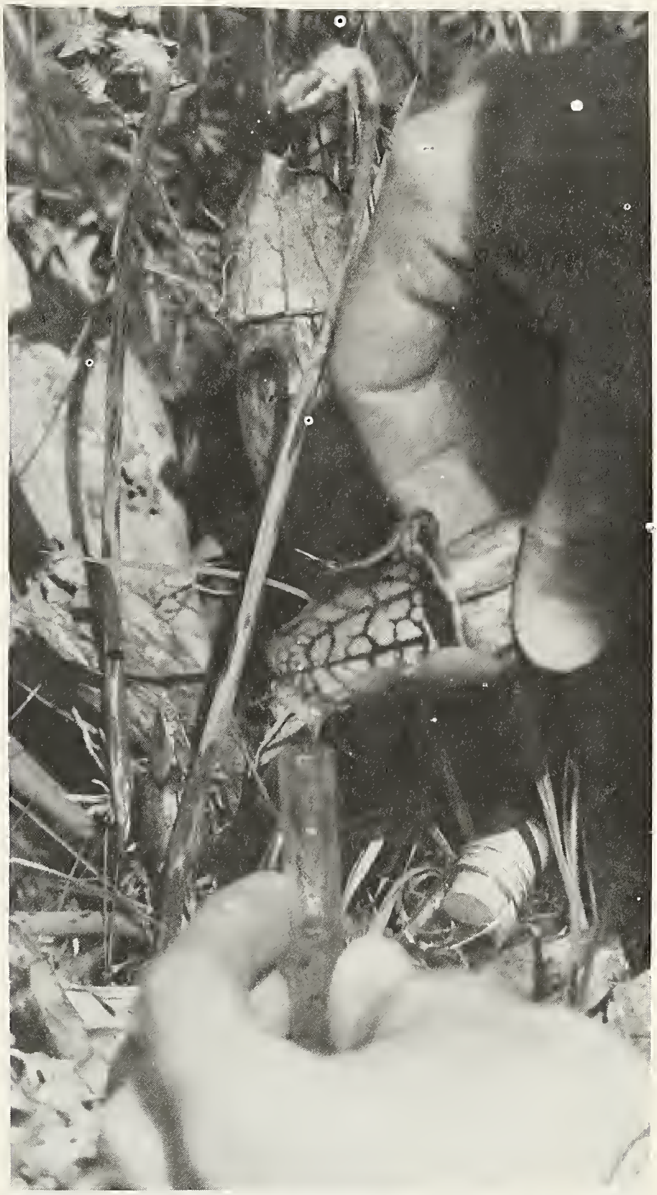

Figure 12. Collecting *Wyeomyia smithii* larvae from the leaf of a pitcher plant, *Sarracenia purpurea* L.

The larvae and pupae of *Coquillettidia perturbans* are unique in that they attach to the roots and stems of aquatic vegetation. The pupae attach tenaciously and can be collected only by removing the vegetation and examining it very closely. The larvae, however, quickly detach from the vegetation and bury themselves in the mud or sand when the plants are disturbed. They can be collected by first removing the plants from a small area (about 1–2 feet square), then transferring the top 1 to 2 inches of mud or sand from the bottom of the area to a large, shallow, white enamel pan, allowing the water to clear and removing the larvae with a bulb syringe after they surface. Since larvae sometimes remain submerged for periods of an hour or longer and they are extremely difficult to collect when buried in soil, this is often a difficult and time-consuming method. An easier method is to use a trap, such as that described by Bidlingmayer (1954). This trap consists of a sheet metal cylinder long enough to reach the water surface when it is pushed into the mud after the plants have been removed and a cone-shaped insert which allows the larvae to surface, but prevents them from returning to the bottom. The larvae are then removed from above the cone with a syringe.

PRESERVING IMMATURE STAGES—Larvae may be preserved in the field if necesary in 70- to 80-percent ethanol or 10-percent formalin, but the author has found AGA solution preferable. This solution is prepared in advance by mixing glacial acetic acid, glycerin and 70- to 80-percent ethanol at the ratio of 1:1:8, respectively. To preserve larvae in the field in either AGA or ethanol, transfer them to a vial (4- to 6-dram homeopathic type is recommended), remove most of the water with a pipette, refill the vial with preservative, label and stopper. To preserve in formalin, transfer the larvae to a vial; remove the water and add a small amount of 100-percent formalin (40-percent formaldehyde); then add water to make a 10-percent solution; label and stopper. The preservative should be replaced upon returning to the laboratory.

Usually, better specimens are obtained if live larvae and pupae are taken to the laboratory in collecting jars and preserved there. Kill first and second instar larvae by dropping them into 100-percent formalin, then add water to make a 10-percent solution. Third and fourth instar larvae can also be preserved in formalin which helps to retain the gills, but causes darkening of the larvae. To obtain the highest quality specimens, transfer larvae to fresh water; heat the water gradually until the larvae are killed and rise to the surface; transfer the larvae to AGA or 70- to 80-percent ethanol in a beaker, wide mouth jar or petri plate, laying them in a single layer on the bottom, which allows them to harden in a horizontal position. After 24 hours, transfer the larvae to vials of fresh preservatives, label and stopper.

When live pupae are taken to the laboratory, transfer them, using a large bulb syringe, to individual 8- to 10-dram shell vials containing about 10 ml of fresh water, then loosely plug the vials with cotton. Pupae should be examined at least once a day. As soon as possible after emergence, aspirate the adult mosquito, transfer it to a clean dry vial containing a small piece of loosely crumpled paper for the mosquito to rest on and plug the vial with cotton. After a day, the adult mosquito can be killed by putting a drop of chloroform or ethyl acetate on the cotton and inverting a jar over the vial to contain the fumes. The pupal exuvium should be transferred as soon as possible and at least within 24 hours of emergence to 70- to 80-percent ethanol or AGA for preservation until it can be slide-mounted as described on page 16.

TEMPORARY POOL
UNCAS ROAD. INLET, N.Y.
10 MAY 51
COLL. H. JAMNBACK
A. INTRUDENS IV
DET. HAJ & R. MEANS
NYSM 6.10.73-10

Figure 13. Sample label for alcohol-preserved specimens

Vials containing specimens should each contain a label giving the collection data, including the place, date and collector; species; metamorphic stage; instar(s) if applicable and any other pertinent information (fig. 13). Labels should be typewritten or hand-printed in pencil or permanent black ink. Loose labels should never be placed in vials with mosquito specimens; instead they should be made the full height of the vial and long enough to wrap at least halfway around the inside circumference of the vial. Labels should be prepared from good quality bond paper and rinsed with preservative prior to being placed in the vials, especially if collection data are typewritten. Although several styles and sizes of vials are available and suitable for liquid storage of specimens, the author has found 4-dram homeopathic lip vials most satisfactory. Several smaller shell vials containing parts or exuvia of the same specimen plugged with cotton can be placed in these if desired (fig. 14).

Cork stoppers are suitable for storage of less than a year, but neoprene stoppers are best for long-term storage. To use a neoprene stopper, first dry the inner edge of the vial, insert the stopper and release the internal gas by inserting a metal probe (e.g., a microspatula or scissor blade) between the edge of the vial and the stopper. If this precaution is not taken, the stopper is likely to be forced out of the vial after a few hours.

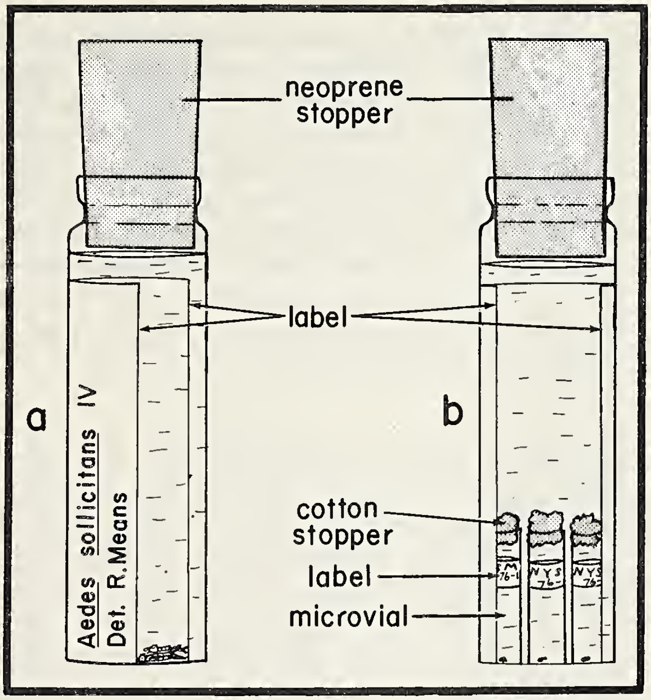

Figure 14. Specimen vial: a. single vial; b. vial containing microvials

COLLECTING ADULTS—Newly emerged mosquitoes often rest in high grass and brush in the vicinity of their breeding sites and males, especially, of many species are most easily collected by sweeping a net above the vegetation (fig. 15). Sweeping is usually most productive in brush or grass along the margins of streams, ponds, marshes or temporary pools and within marshes and swamps. Adults of many species often rest among the roots of overturned trees in a marsh or swamp and can be disturbed into flight by tapping on the roots with a stick, by shaking a leafy branch between the roots or by tossing sand among the roots. Care should be taken when sweeping mosquitoes that the net does not get wet or brush into the vegetation and that only a few specimens are collected at a time before being transferred to a collecting tube or jar, using an aspirator.

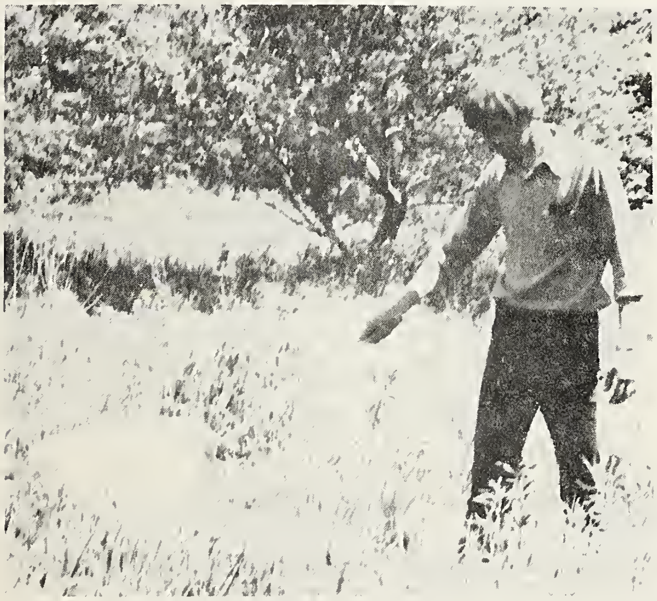

Figure 15. "Sweeping" vegetation for adult mosquitoes

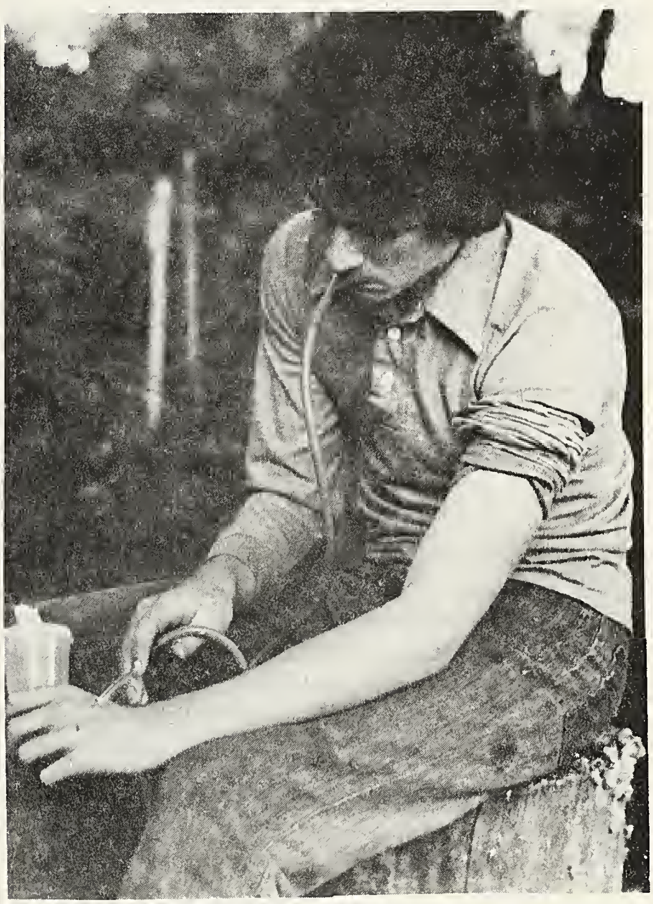

Figure 16. Collecting female mosquitoes attracted to man

Landing/biting collections are often the most productive for collecting several species of female mosquitoes, including some species which are not attracted to light. This type of collection can be made by one person, but is usually more efficient with two persons, one acting as bait, the other collecting mosquitoes landing on him. A site protected from the wind should be chosen, the arms and possibly the legs of the person acting as bait exposed. As mosquitoes land, they are removed with an aspirator and transferred to a collecting jar (fig. 16). If it is desired to obtain blooded females for oviposition, single specimens can be allowed to feed and be isolated in shell vials. Unless mosquitoes are actually observed feeding, it is usually not possible to distinguish between "landing" (or annoying) and "biting" and these collections should be regarded as landing collections. Different species of mosquitoes can sometimes be obtained by making landing/biting collections using different species of animals as bait, especially birds or coldblooded animals rather than mammals.

Many species are attracted to light sources of all kinds and colors except those in the yellow and orange color range. Females and males rest on vertical and horizontal surfaces from a few inches to several feet from the light source and may be collected with an aspirator, or if there are many specimens, a net may be used. Sometimes it is advantageous to place a portable gasoline or battery-powered lantern in a place where lights are not normally found and provide white surfaces (e.g., bedsheets) both horizontally under the light and vertically a few feet from it for mosquitoes to rest on. Standard light traps of two types are often used for collecting quantitative data on mosquito populations. The New Jersey trap (fig. 6b) has been a standard population measuring device for several years in most mosquito control districts throughout the country, but the specimens collected in these traps are often in poor condition for taxonomic study. The newer CDC miniature trap (fig. 6a) is rapidly becoming the preferred trap because it is small and light and the specimens collected are usually in better condition. Light traps should be placed in protected places at varying heights above the ground since different species are normally found at different heights; for example, *Aedes cinereus* is generally found near the ground while *A. triseriatus* is most common about 5 feet above the ground. The collecting jar on a New Jersey trap may contain either a dry killing agent such as cyanide covered with plaster, or it can contain a liquid preservative such as 70- to 80-percent ethanol or AGA solution. Miniature light traps (CDC) are equipped with a large net bag to collect specimens alive. To anesthetize them, the collector may either suspend the bag in a closed container treated with chloroform or ether, or in a freezer for a short time. After they are immobilized, they may be transferred to a killing jar or to a cage or vial for oviposition.

PRESERVING ADULT SPECIMENS—Adult mosquitoes may be collected and preserved in liquid; either 80-percent ethanol or AGA solution. There is usually less breakage by this method, but special techniques are required for identification (Means, 1963). They are usually collected and mounted dry, either glued to a paper or plastic insect point or pierced with a minuten nadeln. With either method, the specimen is positioned to the left side of a No. 1 insect pin with the head facing away from the technician. Prior to mounting, adult specimens should be relaxed for about 1 hour in a relaxing jar to soften the integument and reduce loss of appendages.

When mounting on a point, a small drop of glue (white glue is preferred by the author) is placed on the tip of the point and the left side of the thorax of the specimen placed in the glue, the legs directed toward the insect pin (fig 17). Care should be taken that the glue is not excessive; a drop transferred with the tip of an insect pin is usually sufficient.

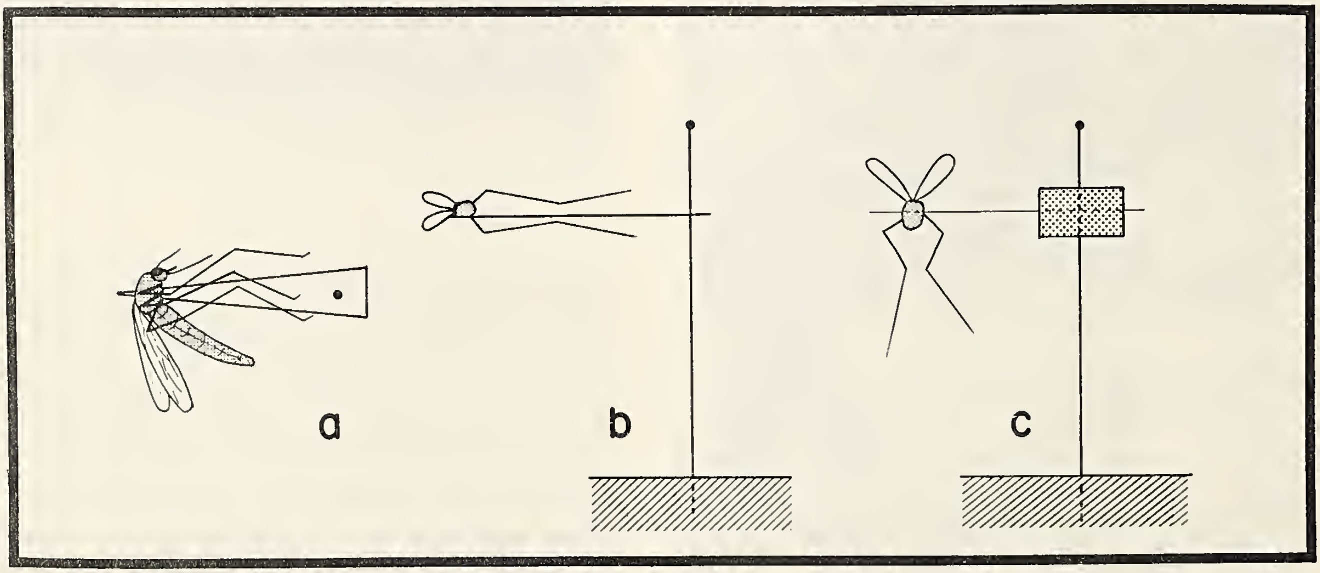

Figure 17. Methods of mounting adult mosquito: a. and b. mounted on paper point, top and side aspect, respectively, c. mounted on minuten nadeln

To mount on minuten nadeln, the blunt end of the minuten is inserted into the end of a small cork block which is pierced perpendicularly at the opposite end with an insect pin. The specimen is then pierced with the minuten either from the right side of the thorax or from the sternum between the midcoxae (fig. 17c). A very small amount of thin glue may first be applied to the minuten to help hold the specimen.

SLIDE MOUNTS—After using several kinds of mounting media including diaphane, balsam, clearcol and PVA, the author now uses and recommends Hoyer's for exceptionally clear semipermanent preparations and Euparol for permanent slides of immature stages and parts of adult mosquitoes. Hoyer's is an aqueous medium which is excellent for preparing slides having exceptional optical properties. Fine setae and other detailed structures not visible in other media, especially on first instar larvae, are quite clear in Hoyer's mounts. However, like other aqueous media, Hoyer's will eventually dry out and is not recommended where permanence is required. The author has found Euparol most satisfactory for making permanent slide preparations of all mosquito material. Although slides prepared with Euparol are not quite as clear as those made with Hoyer's, they are generally better than those prepared with other media such as balsam or diaphane. Also, since Euparol is miscible with 95-percent ethanol, it is not necessary to dehydrate specimens as with some other media. Recommended procedures for using Hoyer's and Euparol are discussed briefly here and in the chapters dealing with the various life stages. For additional information, consult Belkin (1962).

Regardless of the mountant used or the specimen being mounted, certain precautions and procedures are recommended: (1) handle the specimen as little as possible; decant liquids rather than transferring specimens whenever possible; (2) transfer specimen, when necessary, with a hooked pin rather than forceps; (3) label all dissected parts of each specimen with the same reference number and keep all labels with their associated specimens throughout processing; provide each finished slide with a permanent label; (4) whenever possible, mount associated stages and parts of the same specimen on the same slide.

HOYER'S MOUNTS—Hoyer's medium is prepared as follows:

1. Gradually add 30 grams of gum arabic to 50 ml of water until dissolved. This may take as long as 2–3 days.
2. Let solution stand overnight or longer, then filter through two or more thicknesses of muslin. This may take several days as the solution is quite viscous.
3. Add 200 grams of chloral hydrate. This is best accomplished with the gum solution in a hot water bath.
4. Add 20 ml of glycerin.

Prepare slides using Hoyer's medium as follows:

1. Transfer the specimen from preservative (or water, if freshly killed) to 95-percent ethanol for 15 minutes to 1 hour depending upon the size of the specimen.
2. Transfer to a drop of Hoyer's diluted 2:1 with water on a slide.
3. Using two insect pins, microdissecting needles or a microscalpel, dissect and position the specimen.
4. Place four supports for a coverslip in the mountant around the specimen. Supports may be broken pieces of coverslip, but the author has found pieces of 3-ply bristol board 1–2 mm square to be more convenient and uniform.
5. Let stand in a dust-free place for 1–2 hours or more to anchor the specimen.
6. Spread full strength Hoyer's on a 18–22 mm round coverslip and invert it over the specimen(s).
7. Lay the slide on a warm hotplate or slide-warming table just until the Hoyer's begins to bubble (a few seconds), remove and cool rapidly by laying flat on a cool surface such as the worktable.
8. Dry in an oven at 40–45 degrees C for 2–3 days, adding Hoyer's as necessary.

EUPAROL MOUNTS—Specimens may be mounted in Euparol directly from 95-percent ethanol, but the following procedures are recommended for superior mounts:

1. Transfer specimen from preservative to fresh 80-percent ethanol for 1 hour or more.
2. Replace ethanol with 95-percent ethanol for 15–45 minutes depending upon the size of the specimen.
3. Transfer specimen to clove oil until it sinks (15–30 minutes usually).
4. Transfer to a drop of thin Euparol on a slide, dissect and position.
5. Position four coverslip supports (bristol board or broken coverslip) as with Hoyer's.
6. Let stand in a dust-free place for 2–4 hours or more to anchor specimen.
7. Spread undiluted Euparol on a 18–22 mm

round coverslip and invert over specimen as with Hoyer's.

8. Dry in an oven at 45–50 degrees C for 2–3 days or at room temperature for 2–3 weeks, adding Euparol as necessary.

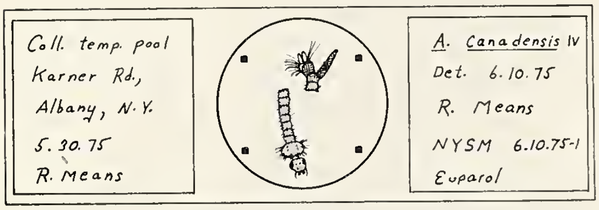

Figure 18. Slide mount of mosquito larva, fourth instar, *Aedes* sp.

MOUNTING PROCEDURES—

WHOLE LARVAE (fig. 18)

1. Transfer larva from ethanol to a drop of thin Hoyer's or from clove oil to thin Euparol on a slide.
2. Puncture side of thorax with a dissecting needle or insect pin to allow mountant to enter specimen.
3. Position with head of specimen toward technician, dorsal side up.
4. Sever culicine larvae between seventh and eighth abdominal segments with a sharp microscalpel or two insect pins so that anal segment and siphon will lie flat. Leave anopheline larvae whole.
5. Complete procedure as described for general slide preparation.

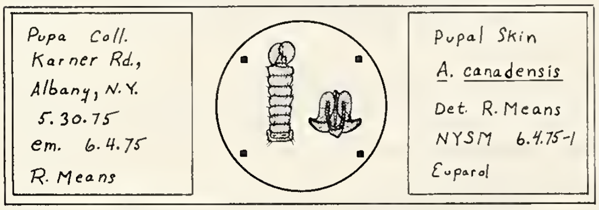

Figure 19. Slide mount of pupal exuvium, Aedes sp.

LARVAL AND PUPAL EXUVIA (fig. 19)

Since species determinations cannot be made from entire pupae (Barr, 1958) the adults must be allowed to emerge and the pupal exuvia prepared for study. Exuvia may be stored in 70- to 80-percent alcohol or AGA solution, but they must be mounted on slides for taxonomic study. If fourth instar larval exuvia are available, they should also be preserved and preferably be mounted on the same slides as the associated pupal exuvia (Belkin, 1962). To prevent deterioration and assure that preparations are taxonomically useful, exuvia must be removed from water and preserved in alcohol or some other preservative within a day following pupation or adult emergence (Barr, 1963). Larval exuvia are mounted in the same manner as whole larvae.

Pupal exuvia may be mounted in balsam by dehydrating in cellosolve or 95- to 100-percent ethanol, then clearing in beechwood creosote or clove oil (Barr, 1958; Darsie, 1951). The author has had better success with less loss of setae by mounting them in Euparol as described by Belkin (1962). The recommended procedure is as follows:

1. Transfer the alcohol-preserved specimen to fresh 75- to 80-percent ethanol for about 1 hour.
2. Decant ethanol and replace with 95-percent ethanol for about 30 minutes (not longer than 1 hour).
3. Transfer specimen to clove oil until it sinks (about 30 minutes).
4. Separate cephalothorax from metanotum and abdomen using two dissecting pins.
5. Transfer the parts to thin Euparol on a slide. If only pupal exuvium is being mounted, place it in the center of the slide under a large (22 mm round) coverslip; if both larval and pupal exuvia are being mounted, place pupa to the right of the center and larva on the left under a 22 × 50 mm coverslip or two 22 mm round coverslips.
6. Open cephalothorax and break, if necessary, the narrow connecting strip; flatten it with the ventral side up. Place abdomen and attached metanotum ventral side up, flatten it, then turn it over and mount it dorsal side up.
7. Position four small pieces (2 mm square) of illustration board (3-ply bristol) around the specimen to support the coverslip.
8. Let Euparol dry for about 2–3 hours in a dust-free place, making sure that the specimens are covered with Euparol.
9. After the specimens are firmly anchored (2–3 hours), place thick Euparol on a coverslip and invert it over the specimen. The slide may be examined after 24 hours, but must be stored flat for about a week.

MALE TERMINALIA (fig. 20)

1. Dissect terminal abdominal segments at about the middle of segment VII. On alcohol-preserved specimens, this is easily done with two insect pins or a microscalpel;

on dry material, first soften the specimen in a relaxing jar for about 1 hour, then clip the abdomen with microdissecting scissors, allowing the terminalia to fall into a dish of 70- to 80-percent ethanol.

2. Transfer specimen to warm 10-percent KOH (50 degrees C) and either heat gently (50 degrees C) in an oven for 30 minutes or let stand for 10–12 hours at room temperature. The latter method is often more convenient and produces quite satisfactory results.
3. Transfer specimen to distilled water for 1–2 hours.
4. Replace water with 70- to 80-percent ethanol for 30–45 minutes.
5. Transfer specimen to thin Hoyer's on a slide *or* to clove oil in a dish until it sinks, then to thin Euparol on a slide.
6. Position specimen with the dististyles toward technician, spread so as not to obscure other parts, and with the proctiger in the dorsal position.
7. Using two insect pins or microdissecting needles, gently pull the genitalia out from within segment VIII.
8. Complete procedure as described for general slide preparation.

TERMINOLOGY AND MORPHOLOGY

LARVA—Mosquito larvae are most often studied in the fourth (last) instar primarily because this is the largest and most easily handled stage, and because the identifying characteristics are less variable than in instars two and three. First instar larvae have been largely ignored, especially by the earlier taxonomists, probably due to their small size. However, Marshall (1938), Bohart (1954), Dodge (1966), Belkin (1962) and others have shown that, although first instar larvae require somewhat different techniques for study, they can be accurately identified.

The larva has a head, thorax, and abdomen containing setae and other structures useful for identification purposes. Several systems have been proposed for numbering and naming setae used in classification of mosquito larvae. In this paper, the setae are numbered and named according to Belkin (1951, 1962), and Dodge (1966). For additional information regarding setal nomenclature and morphology, consult these authors, Ross & Roberts (1943) and Carpenter & LaCasse (1955). The following setae and structures normally used in identification of mosquito larvae are illustrated in figs. 32, 33, 34 and 35.

HEAD—

Preclypeal spine (1)

Inner (2) and outer (3) clypeals: used in the identification of anophelines.

Frontals (5, 6 and 7): in anophelines these hairs are in a transverse row; in other genera they are arranged in various ways and are often referred to as the upper head hair (5), lower head hair (6) and preantennal hair (7). The positions of these hairs are often different in the first instar than in later instars (Dodge, 1966; Hearle, 1929).

Posterior clypeal (4)

Inner (8) and outer (9) occipitals: located on each side of the epicranial suture, hair 8 anterior to 9 and often very long in the first instar.

Orbital hair (10)

Subantennal hair (11): used primarily in the identification of first instar *Anopheles.*

Antenna: The length (relative to the length of the head capsule), color, shape and surface texture of the antenna are often used in the identification of some species, especially in *Aedes* and *Culex.*

Antennal hair (1): The position and branching of the antennal hair, sometimes referred to as the shaft hair, are important in some groups.

Terminal hairs or spines of antenna (hairs 2–6): Comparative lengths of these hairs are useful in the identification especially of first instar *Anopheles* and some later instar *Aedes.*

THORAX—

Prothoracic hairs 1, 2 and 3: comparative lengths are useful in the identification of some *Aedes.*

Metathoracic hairs 7 and 9–12: Both hairs 7 and a tubercle bearing hairs 9–12 are present on instars III and IV, but hair 7 is absent on instars I and II.

ABDOMEN—The abdomen is composed of eight distinct segments, the eighth apparent segment actually being part of the eighth and ninth segment, and a tenth (anal) segment (Snodgrass, 1959). The eighth and ninth segments bear the respiratory apparatus including a pair of large spiracles which are either flush with the body as in *Anopheles* or borne at the end of a respiratory tube, the siphon.

Lanceolate hairs: Hair 1 of thorax and most abdominal segments is lanceolate on first instar *Anopheles.*

Lateral abdominal hairs (hairs 6 and sometimes 7): The length of these hairs on some abdominal segments, usually compared to abdominal hair 1, is important in some *Aedes* species.

Palmate hairs: Abdominal hair 1 of most later instar *Anopheles.*

Stellate hairs: Abdominal hair 1 on later instars of some species of *Aedes* (fig. 104).

TERMINAL ABDOMINAL SEGMENTS AND STRUCTURES—

Comb: The comb is made up of few or many *comb scales* arranged in a single or double row or a patch and is located on each side of the eighth abdominal segment of most nonanopheline mosquito larvae. The scales may be lanceolate, spinelike or spatulate, and may arise from the posterior border of a sclerotized plate.

Pentad hairs (hairs 1–5 of the eighth abdominal segment): Hairs closely associated with the comb and situated in a semicircle posterior to it, the positions and relative lengths of which are used in the identification of first instar larvae.

Siphon: The air tube on nonanopheline mosquito larvae is composed of abdominal segments VIII and IX bearing two pairs of spiracles at the apex (Snodgrass, 1959; Belkin, 1962). In later instars, the siphon is almost entirely sclerotized, but, in first instar larvae, the basal portion is unsclerotized. The ratio of the "primary zone of sclerotization" to the "secondary zone of sclerotization" on the distal portion is sometimes important for species determinations. The "siphon index" is the ratio of the dorsal length to the median width of the siphon and is often referred to in keys, particularly of later instar larvae.

Pecten: A paired row of comblike spicules along the ventrolateral surface of the siphon. The length of individual pecten teeth compared to comb scales or to the dorsal preapical spine, the ratio of the length of the entire pecten to the siphon and the positions of individual teeth (evenly spaced or the distal teeth separated from the others) are important characteristics used for the identification of some species.

Pecten plate: A sclerotized toothed plate on each side of the spiracular lobe of *Anopheles* larvae. The paired lateral plates are connected ventrally and are probably homologous to the siphon of larvae in other genera.

Acus: A small sclerotized area at the base of the siphon, either attached to or detached from the siphon.

Dorsal preapical spine: A laterodorsal hair or spine near the apex of the siphon. The length of this spine compared to the apical pecten tooth in later instars or its position on the siphon in first instar larvae is useful in determining some species.

Saddle: A sclerotized plate covering some or all of the dorsal and lateral surfaces of the anal segment. In most species, the proportion of the anal segment covered by the saddle increases with each larval instar. The proportion covered in the fourth instar varies with the species, the saddle being complete (entirely surrounding the segment) in some species, incomplete (interrupted ventrally) in some and absent in some.

Saddle hair (lateral hair of anal segment): The length relative to the length of the saddle and the number of branches are important characteristics in the identification of some species. The position relative to the ventral and posterior margins of the saddle is helpful in determining the larval instar.

Caudal hairs: Two pairs of long hairs, usually referred to as dorsal tufts by most American authors, situated above the saddle on the anal segment. The number of branches and relative lengths of these hairs are sometimes used for species determinations.

Ventral brush: A group of several irregularly paired hairs along postero-ventral region of the anal segment, present only on instars III–IV. This ventral brush is extensive in most genera, composed of many hairs, each usually with several branches, at least on instar IV. In *Wyeomyia* the ventral brush is reduced to a single paired tuft.

Gills: Two pairs of variously developed, usually elongate processes, sometimes referred to as *anal papillae*, surrounding the anal opening. These gills are not used for respiratory purposes, but rather to maintain the physiological balance of water in the body (Snodgrass, 1959; Wigglesworth, 1933). The length varies considerably among species and within a species, depending at least partially upon the salinity of the water, with the gills on larvae in saline water usually being shorter than those in fresh water. However, the length of gills and, especially, the length of the dorsal pair relative to the ventral pair is often helpful in making species determinations.

PUPA—Mosquito pupae are easily prepared for study and have taxonomic characters which are useful in separating at least genera and often species. However, pupae are not usually used for species determinations because identification is easier and more certain in the larval or adult stage. One notable exception is that pupae of *Aedes abserratus* are easily separated from

TABLE I

Pupal setal signatures of Barr (1963) and those of Darsie (1951) and Penn (1949).

	Setal signature	
Abdominal segment	Bar (1963)	Darsie (1951) and Penn (1949)
I	2	H
	3	M
	4	K
	5	L
	6	S
	7	T
	9	U
II–VIII	1	C
	2	C′
	4	B
	5	4
	8	6
	9	A
	0	5
II	3	3
	6	2
	7	1
III-V	s (dorsal sensillum)	3
III-VIII	3	2
	6	1
IX	1	2

other species of the *A. punctor* group while adults are often difficult to separate (Darsie, 1957). Keys to the known pupae of species occurring in New York are included. Descriptions of individual species are not discussed since the only major differences are size and branching of setae.

The pupa consists of a bulbous cephalothorax and a tail-like abdomen which is composed of 10 segments and a terminal pair of large, oval paddles. Locations, lengths and branching of setae on the cephalothorax, the metathorax and the abdomen are of primary importance in species determinations. The most generally accepted method for numbering these setae is that described by Belkin (1952, 1953, 1962), Barr (1963) and Barr & Myers (1962), who have demonstrated homologies between the setae of larvae and pupae. The only major difference between the numbering systems of these authors is the reversal of setae 3 and 4 of abdominal segments V and VI. This paper follows the system of Barr in which seta 4 is usually medial of 3. The setal signatures of Darsie (1949, 1951, 1957) and Penn (1949) are listed in table I, indicating their analogies to the numbering systems used in this paper.

Pupal structures and setal arrangements are illustrated in figures 143 and 144. The structures commonly used in identification of pupae are:

CEPHALOTHORAX—The cephalothorax, including the metathorax, which is normally left attached to the abdomen in mounting, has 12 setae. The position of hairs 10, 11 and 12 on the metathorax are sometimes used in species determinations.

Trumpet: A paired respiratory organ on the dorsal plate of the cephalothorax, consisting of a *tubular portion* (meatus) and a *distal opening* (pinna) (fig. 171). The trumpet is often used in determinations of genera and species.

ABDOMEN—

Segment I: This segment has only a tergum, usually with nine setae on each side.

Float hair: Seta 1 of segment I is usually represented as a dendritic (treelike) tuft which aids in keeping the pupa afloat.

Segments II–VII: These segments have well-developed sternites and terga, but no pleura; they have a varying number of setae numbered 0–14 which vary also in position, length and branching.

Segment IX: This segment is sometimes referred to as the *anal flap*; it is fused immovably to the tergum of segment VIII, lying dorsad of the paddles.

Segment X: This segment is sometimes called the *genital pouch;* it is attached to the sternite of segment VIII, lying ventrad of the paddles (Moorefield, 1951). In some genera, this segment contains a small seta.

Paddle: A large, oval, paired terminal appendage used in propelling the pupa. The presence of setae and marginal hairs, spines and/or denticles often serve as taxonomic characters.

SEXUAL DIMORPHISM—Although the sexes of pupae of a single species can often be separated by size, the males usually being smaller (Fay & Morlan, 1959; Grose *et al.*, 1966; McCray, 1961), there is frequently size overlapping even within a species. Moorefield (1951) and Carpenter (1952) have shown that sexual dimorphism is evident in the 10th abdominal segment (genital pouch) which is larger and bifurcate nearly to the base in males, shorter and broadly rounded or only slightly indented posteriorly in females. The sex of a live pupa can be readily determined by drawing it into a transfer pipette and examining it with the aid of a dissecting microscope or hand lens.

ADULT FEMALE—The adult mosquito is composed of a head, thorax and abdomen, each having structures which are useful for identification of species.

HEAD—

Proboscis: Elongate mouthparts modified for piercing and sucking in most adult female mosquitoes. The proboscis is composed of a labrum, hypopharynx, paired mandibles and paired maxillae, all styletlike, enclosed in a soft, sheathlike labium. These mouthparts are illustrated in figures 201a, b. The proboscis is clothed with scales which are usually dark, but may include pale scales either scattered or in transverse bands.

Antenna: An elongate antenna is composed of a large globose pedicel, or torus, and a flagellum which is divided into 14 sections (erroneously called segments according to Snodgrass, 1959). Each, except the first, of these flagellar sections contains a sparse whorl of hairs arising from near the base. The torus is usually bare, but may contain patches of scales on either the inner or outer surfaces or both (fig. 206).

Occiput: An area at the vertex and posterodorsal surface of the head which contains several types of scales; the types, colors and positions of which vary and are useful in the identification of some mosquitoes, especially in the genus *Aedes*.

Palps: The maxillary palps are about as long as the proboscis in anophelines and only about one-fifth as long in culicines. They are usually dark-scaled, but sometimes have scattered pale scales or transverse bands of pale scales.

PROTHORAX—The prothorax is greatly reduced and is composed, on each side, of the anterior pronotum, posterior pronotum and propleuron. Each of these areas may bear bristles and/or scales useful in determinations of genera and species. The prosternum is located between the fore coxae.

MESOTHORAX—The mesothorax comprises the largest part of the thorax; it is composed of the dorsal mesonotum, which covers nearly the entire thoracic region, and lateral pleurae, which are composed of several sclerites and membranous regions.

The mesonotum is composed of the scutum, a large dorsal plate covering most of the thoracic area; scutellum, a rounded or trilobed structure posterior to the scutum; and the postnotum, a convex structure between the scutellum and the metanotum. The type, color and pattern of scales on these structures are useful in identification of some species.

The sclerites and membranous regions of the lateral pleurae are illustrated in figure 206. The position and number of bristles, and the type, size and pattern of pleural scale patches are some of the most useful characters in the identification of genera and species. The sclerites and membranous areas are as follows:

Sternopleuron: A large, ham-shaped sclerite below the postspiracular area.

Mesepimeron: A large, subrectangular sclerite adjacent to the posterior margin of the sternopleuron.

Meron: A small, triangular sclerite just above and behind the second coxa.

Postspiracular area: A rounded sclerite just behind the anterior spiracle.

Subspiracular area: A membranous area below the anterior spiracle and adjacent to the posterior pronotum and propleuron.

Hypostigial area: The uppermost part of the subspiracular area, near the anterior spiracle.

Postcoxal area: A membranous area between the fore coxa and the sternopleuron.

Bristles commonly used for generic or specific determinations are:

Spiracular bristles: A row of fine bristles in the subspiracular area just posterior to the posterior pronotum and anterior to the anterior spiracle.

Postspiracular bristles: A row of fine bristles in the membrane just posterior to the anterior spiracle.

Sternopleural bristles: Bristles on the posterior margin of the sternopleuron.

Lower mesepimeral bristles: Bristles on the mesepimeron near the lower anterior margin. The number of bristles in this position is a useful character to separate some genera and some species of *Aedes*.

Wings: The mesothoracic wings have a similar characteristic venation in all mosquitoes, with some minor differences which serve to separate some genera and species. The wing is elongate oval and has scales of varying shape and coloration on the veins and a fringe of scales along the posterior margin. The typical venation is illustrated in figure 207.

Halteres: The metathoracic wings are reduced to short knoblike appendages called halteres. These are used for balance in flight. The color of scales on the halteres is sometimes useful in species determinations.

Legs: Three pairs of legs arise from the prothoracic, mesothoracic and metathoracic regions. Each is composed of a coxa, trochanter, femur, tibia and five-segmented tarsus bearing a terminal claw (fig. 226). The types and colors of scales ornamenting the legs are useful in species determinations, as are the shapes of tarsal claws.

METATHORAX—The metathorax is greatly reduced and is composed of the following structures:

Metanotum: A narrow transverse band (usually indistinct) connecting the postnotum with the first abdominal tergite.

Metameron: A very small lateral sclerite just behind the meron and the metacoxa. The presence of scales on this structure is used as a diagnostic character for some species.

Metapleuron: A large sclerite lying posterior to the mesepimeron.

ABDOMEN—The abdomen is composed of 10 segments, the first eight of which are unmodified. The ninth and tenth segments are modified for copulation and vary among genera, the apex of most genera being rounded but tapered in *Aedes* and *Psorophora*, with segment VIII withdrawn into segment VII. Each segment is composed of a dorsal tergite and a ventral sternite connected by a lateral membrane. Scale patterns on these segments, particularly the tergites, are often used for species determinations.

ADULT MALE—Males of most species of mosquitoes are similar to females of the same species in general appearance, including scale patterns and other color markings, and can usually be identified using the keys for females. The primary differences between males and females are: (1) males have only sucking mouthparts while most females have mouthparts which are adapted for piercing skin and sucking blood; (2) the antennae of males are bushy with numerous large whorls of setae while females have widely spaced whorls of few short setae; (3) the maxillary palps of males are approximately as long as the proboscis, but are only about one-fifth as long as the proboscis on females of most genera (long on anophelines); (4) terminal segments are adapted for mating with the female.

The color patterns on both females and males vary considerably within a species, but the structures of the male terminalia, which are distinctive for most species, are usually quite consistent. Therefore, it is these structures upon which most species descriptions are based. Shortly after emergence, the terminal segment (segment IX and associated structures) rotate 180°, with the tergite located on the lower surface and the sternite on the upper. This text and illustrations use the correct morphological terms regardless of position. Structures of the male terminalia normally used for species determinations are illustrated in figure 20.

Ninth tergite (IX-T): Ventral surface of a chitinous ring which, together with its associated lobes (IX-TL), provides useful diagnostic characters.

Ninth tergal lobes (IX-TL): A pair of lobular expansions of the ninth tergite bearing stout spines; the number, position and nature of these spines and shape of this structure are useful in species determinations.

Ninth sternite (IX-S): Broad chitinous dorsal expansion, usually unmodified, connected to IX-T by narrow pleurae.

Sidepiece: A large, paired, forcepslike appendage arising from the ventrolateral margin of the ninth sternite, consisting of a basistyle (Bs) and dististyle (Ds).

Basistyle (Bs): A large, hollow appendage arising from the ventrolateral margin of IX-S which may possess apical, subapical or basal lobes on the inner, or mesal, surface. These lobes, if present, may bear spines, rods and leaflike appendages which are important in generic and specific determinations.

Dististyle (Ds): An articulated appendage borne at or near the apex of the basistyle, usually with an articulated claw (Ds-C) at the tip. The shape and point of origin of the dististyle on the basistyle and the shape of the claw offer useful diagnostic characters.

Phallosome (Ph): A chitinous structure located between the proctiger, basistyle and sternite IX which is composed of an intromittant organ, the aedeagous (Ae); basal plates (B-P); ventral, and sometimes dorsal, parameres (Pm). The homologies of the various components are poorly understood, but they offer good diagnostic characters in different genera.

Proctiger (PR): The anal lobe including all structures distad of segment IX. The 10th sternite (X-S) is well developed in most genera (vestigial or absent in *Anopheles* and *Uranotaenia*) and the apical armature (spines, hairs, etc.) provide useful diagnostic characters.

Claspette (CL): A bilobed structure located between the bases of the basistyles, ventrad of the phallosome; the lobes are usually connected ventrally and sometimes (in the genus *Aedes*) with apical filaments (Cl-f). This structure offers good generic diagnostic characters.

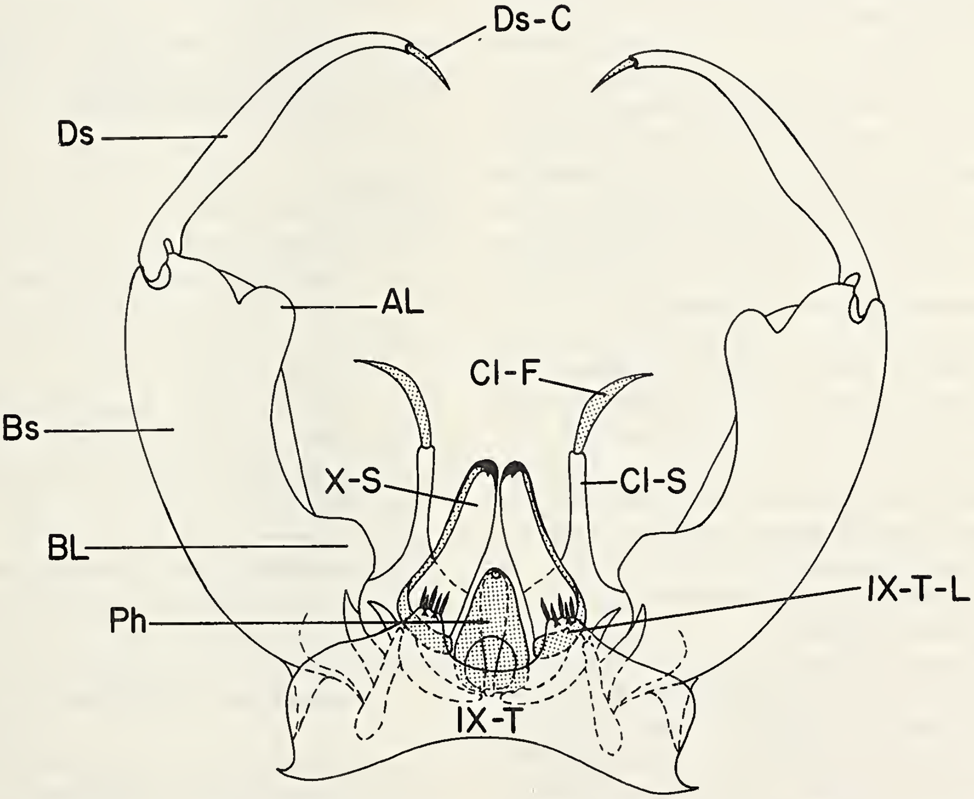

Figure 20. Terminalia of male *Aedes* sp., AL—apical lobe, BL—basal lobe, BS—basistyle, Cl-F—claspette filament, Cl-S—claspette stem, DS—dististyle, C—claw, Ph—phallosome, IX-T—ninth tergite, IX-T-L—ninth tergal lobe, X-S—tenth sternite.

IDENTIFICATION KEYS TO GENERA OF THE FAMILY CULICIDAE

FEMALES

1. Second marginal cell of wing not more than half as long as its petiole (fig. 209); wing squama without fringe of hairs 2

   Second marginal cell of wing at least as long as its petiole; wing squama with or without fringe of hairs (fig. 207) 3

2. Proboscis tapered and curved abruptly downward, palps long and massive (fig. 208); wing length 6.5 mm or more; very large species with broad, metallic-colored scales on head, thorax and abdomen .... *Toxorhynchites*

   Proboscis only slightly curved, palps short; wings less than 3.5 mm long; small species with groups of highly irridescent blue scales on mesonotum and sides of thorax .... *Uranotaenia*

3. Scutellum smoothly rounded with setae arranged evenly around it (fig. 212); palps nearly as long as proboscis (fig. 204); abdomen without scales or only sparsely scaled .... *Anopheles*

   Posterior margin of scutellum trilobed with setae grouped on these lobes (fig. 211); palps less than half as long as proboscis (fig. 201); abdomen densely scaled dorsally and ventrally 4

4. Postnotum with tuft of setae (fig. 213); wing squama without fringe of hairs; abdomen with dark scales dorsally and pale scales ventrally meeting laterally in straight line (fig. 214) .... *Wyeomyia*

   Postnotum bare; wing squama with fringe of hairs (fig. 210); abdominal tergites banded or with lateral spots (figs. 219, 231) 5

5. Spiracular bristles present (fig. 216) 6

   Spiracular bristles absent 7

6. Postspiracular bristles present (fig. 216); tip of abdomen pointed as viewed from above; cerci usually conspicuous (fig. 219); base of subcosta without tuft on underside .... *Psorophora*

   Postspiracular bristles absent; tip of abdomen bluntly rounded as viewed from above; cerci inconspicuous or concealed (fig. 221); base of subcosta with tuft of setae ventrally (fig. 218) .... *Culiseta*

7. Postspiracular bristles present (fig. 217); tip of abdomen pointed when viewed from above; cerci usually conspicuous (fig. 231) .... *Aedes*

   Postspiracular bristles absent; tip of abdomen rounded; cerci inconspicuous or concealed (fig. 220) 8

8. Wing scales narrow, uniformly dark (fig. 225) .... *Culex*

   Wing scales broad, conspicuously dark and light intermixed (fig. 224) 9

9. Hind tarsi with some segments banded on both ends; mesonotum dark with fine lines of sharply contrasting white scales forming a distinctive pattern (fig. 222) .... *Orthopodomyia*

   First hind tarsal segment banded basally and medially, other segments banded basally only (fig. 223); mesonotum with intermixed dark brown and golden scales .... *Coquillettidia*

MALES *

1. Basistyle with one to two stout spines near base; phallosome 4 or more times as long as wide, often with leaflets at tip (fig. 261) .... *Anopheles*

   Basistyle without basal spines; phallosome less than 4 times as long as wide, without leaflets at tip 2

2. Claspettes present (absent in *Aedes aegypti*) (fig. 262) 3

   Claspettes absent 4

3. Dististyle strongly swollen (rarely lobate), *or* dististyle bowed inward, or both (fig. 262) .... *Psorophora*

   Dististyle not strongly swollen; straight or bowed outward (fig. 272) .... *Aedes* (except *aegypti*)

4. Tenth sternite with comb of teeth or crowned with tuft of spines (figs. 263, 264) .... *Culex*

   Tenth sternite simple or with few apical teeth 5

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* Adapted from Scott (1961).

5. Dististyle with three or more branches (fig. 265) .... *Wyeomyia*
   Dististyle simple or with a single lobe near base 6
6. Phallosome platelike, with one or more large teeth on each side (fig. 266) .... *Uranotaenia*
   Phallosome subconical, often with small teeth near tip 7
7. Basal lobe of basistyle with one to two rods at apex, few or no setae (fig. 267) .... *Coquillettidia*
   Basal lobe of basistyle with spines, or numerous small setae 8
8. Claw of dististyle comblike (fig. 268) .... *Orthopodomyia*
   Claw of dististyle spinelike 9
9. Outer edge of basistyle with large scales (fig. 270) 10
   Outer edge of basistyle without large scales .... *Culiseta*
10. Dististyle cylindrical, with subapical spine (fig. 270) .... *Toxorhynchites*
    Dististyle tapering, with apical spine (fig. 271) .... *Aedes aegypti*

IDENTIFICATION OF LARVAL INSTARS—The stage of larval development (instar) can be determined for most species with the following key. First instar larvae are easily distinguished from later instars as follows: (1) they have a median pointed or transverse ridge on the dorsal surface of the head called an egg burster, (2) they lack the ventral brush of the anal segment, (3) most nonanopheline larvae have a bicolored siphon with two distinct sclerotized areas. For additional details of first instar larvae, see Dodge (1966).

MacKenzie (1966) and Smith (1965b, 1969a, b) reported that second and third instars can be easily separated by the presence of two multiple hair tufts on the metathorax of the third instar and only one on the second instar of culicine larvae. These tufts apparently arise from two tubercles, one bearing seta 7 which is lacking in second instar larvae and the other tubercle bearing setae 9, 10, 11 and 12, present on all instars. On anopheline larvae, the palp hair is absent on the second instar, present on the third and the fourth instars.

Fourth instar culicine larvae can usually be separated from the third either on the basis of a complete saddle (never complete in third) or the position of the saddle hair relative to the margin of the saddle (Smith, 1969). The saddle hair of most species which have an incomplete saddle in the fourth instar is situated on the saddle, closer to the posterior margin than the ventral margin, while in the third instar, the hair is inserted either on the membrane below the saddle or closer to the ventral margin than the posterior margin of the saddle. One exception is *Aedes atropalpus*, which has the hair located on the membrane below the saddle in all instars. The fourth instar of all species can usually be recognized by the shape of the saddle which is rectangular rather than rounded ventrally. The fourth instar of *A. atropalpus* can sometimes also be separated on the basis of head measurements (Shaw & Maisey, 1961), but these may vary with locality, depending upon temperature, food and other variable factors. A large, dark area representing the eye of the imago just anterior to the eye of the larva is absent on third instar anophelines, present on fourth instar.

INSTARS OF MOSQUITO LARVAE

1. Siphon present (culicine larvae) 2
   Siphon absent (anopheline larvae) 6
2. Siphon conspicuously bicolored, tipped with black (fig. 34) (except *Coquillettidia*); head with egg burster on vertex (fig. 35); size very small .... First Instar
   Siphon uniformly colored or nearly so; head without egg burster 3
3. Metathorax with single multiple hair tuft on each side (fig. 38) .... Second Instar
   Metathorax with two multiple hair tufts on each side 4
4. Saddle complete; anal plate surrounding anal segment (fig. 99) .... Fourth Instar (pars)
   Saddle incomplete; sides of anal plate not meeting ventrally (fig. 97) 5
5. Saddle hair inserted on saddle closer to posterior margin than to ventral margin or to extension of ventral margin if saddle is incized posteriorly; saddle viewed laterally usually quadrangular, with angular ventral corners; (fig. 97); pupal float hairs may be visible prior to molt ... . Fourth Instar (pars)
   Saddle hair inserted on membrane below saddle or on saddle, but closer to ventral margin than to posterior margin, rarely equidistant; hairs of next instar sometimes evident prior to molt; ventral margin of saddle rounded, without distinct lower corners (fig. 39) .... Third Instar
6. Head with egg burster on vertex; size very small .... First Instar
   Head without egg burster 7

7. Palp hair absent .... Second Instar
   Palp hair present (fig. 33) 8
8. Large dark area representing eye of adult mosquito present anterior to compound eye of larva (fig. 33) .... Fourth Instar
   Dark area representing eye of adult absent .... Third Instar

FIRST INSTAR LARVAE *

1. Air tube absent .... *Anopheles*
   Air tube present (fig. 34) 2
2. Mouth brushes reduced to about 10 stout rods; saddle complete (fig. 36) .... *Toxorhynchites*
   Mouth brushes composed of numerous fine hairs; saddle incomplete (fig. 34) 3
3. Pecten absent (fig. 41) 4
   Pecten present (fig. 34) 6
4. Pentad hairs 1–5 evenly spaced, nearly half-encircling comb (fig. 41) .... *Orthopodomyia*
   Pentad hairs 3–5, approximate (fig. 42) 5
5. Air tube attenuated apically; antennae much longer than head, with a pair of subapical spines (fig. 43) .... *Coquillettidia*
   Air tube not attenuated apically (fig. 42); antennae much shorter than head .... *Wyeomyia*
6. Air tube with three or more pairs of ventrolateral hairs, or with a single pair before middle 7
   Air tube with one pair of ventrolateral hairs beyond middle 9
7. Head elongate, with stout head hairs (fig. 82); saddle nearly complete (fig. 40) ..... *Uranotaenia*
   Head wider than long, with fine head hairs; saddle small, dorsal (fig. 45) 8
8. Air tube with at least three pairs of ventrolateral hairs (fig. 46) .... *Culex*
   Air tube with one pair of ventrolateral hairs (fig. 45) .... *Culiseta*
9. Egg burster a median transverse pointed ridge on pale disk (fig. 47) .... *Psorophora*
   Egg burster a median conical point (occasionally a transverse ridge) on dark disk (fig. 35) .... *Aedes*

SECOND, THIRD AND FOURTH INSTAR LARVAE

1. Eighth abdominal segment with flat spiracular plate, but no siphon (fig. 80); abdomen with palmate hairs (fig. 81) .... *Anopheles*
   Siphon present (fig. 83); abdomen without palmate hairs 2
2. Eighth abdominal segment without comb scales, but bearing two long barbed spines and two small branched setae on large sclerotized plate (fig. 84); abdominal segments 3–7 each with three pairs of lateral plates bearing spines .... *Toxorhynchites*
   Eighth abdominal segment with comb scales (figs. 83, 85) without long barbed spines, with or without sclerotized plates; abdominal segments without lateral plates bearing spines, with or without dorsal sclerotized plates 3
3. Eighth abdominal segment with large sclerotized plate bearing a row of comb scales along posterior margin (fig. 83); head longer than wide; head hairs 5 and 6 single, peglike (fig. 82) .... *Uranotania*
   Eighth abdominal segment without sclerotized plate; head wider than long; head hairs 5 and 6 slender (fig. 88) 4
4. Siphon with pecten (fig. 85) 5
   Siphon without pecten 8
5. Siphon with a pair of branched setae near base (fig. 85) .... *Culiseta*
   Siphon without branched setae near base 6
6. Siphon with several pairs of ventral setae (fig. 88) .... *Culex*
   Siphon with no more than one pair of ventral setae, but sometimes *(Aedes trichurus)* with several pairs of branched setae dorsad of pecten (figs. 91, 94) 7
7. Anal segment completely ringed by saddle, pierced on ventral side by tufts of ventral brush (fig. 86) .... *Psorophora*
   Saddle incomplete, or if complete, not pierced by tufts of ventral brush .... *Aedes*
8. Siphon short, pointed, with teeth along one side (fig. 89) .... *Coquillettidia*
   Siphon elongate, at least twice as long as wide; not pointed and without teeth 9
9. Siphon with numerous setae; ventral brush of anal segment represented by single pair of 2- or 3-branched setae (fig. 90); saddle incomplete .... *Wyeomyia*
   Siphon with one pair of centrally located setae; ventral brush of anal segment consisting of several multiple tufts; saddle complete in fourth instar (fig. 87)......................... *Orthopodomyia*

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* Adapted from Dodge (1966).

PUPAE

1. Seta 9 on segments III-VI stout, spinelike, located at posterior lateral corners of segments (fig. 145); paddle with terminal seta at apex and accessory seta somewhat anterior to apex (fig. 146) .... *Anopheles*
   Seta 9 on segments III-VI located anterior of posterolateral corners, usually minute, simple (fig. 147); terminal and accessory paddle setae, when present, at or near apex 2
2. Outer margin of paddle lobelike and extending posteriorly further than inner margin (fig. 148); seta 6 on segment VI very long, barbed (fig. 147); very large pupa .... *Toxorhynchites*
   Paddle not lobed; seta 6 on segment VI short 3
3. Paddle and segment IX both without setae 4
   Paddle with at least one seta; segment IX with or without setae 5
4. Paddle elongate, notched at apex (fig. 159); float hair small, simple; all setae small and weak (fig. 150) .... *Coquillettidia*
   Paddle oval, evenly rounded at apex (fig. 158); float hair dendritic (fig. 149); most setae well developed, some very long .... *Wyeomyia*
5. Paddle margin mostly smooth; seta 9 on segment VIII anterior of posterolateral corner (fig. 157) 6
   Paddle margin serrate, denticulate or with well-developed submarginal denticles (fig. 152); seta 9 on segment VIII at or near posterolateral corner (fig. 151) 7
6. Segment IX with seta (sometimes difficult to see) (fig. 157); trumpet with basal tracheoid portion (fig. 175); terminal paddle seta single, rarely double (fig. 157) .... *Culex*
   Segment IX without seta; trumpet without tracheoid portion; terminal paddle seta branched (fig. 160) .... *Orthopodomyia*
7. Trumpet long, narrow, with basal tracheoid portion (fig. 177); paddle conspicuously unequally divided by midrib, large and lobelike medially (fig. 153) .... *Uranotaenia*
   Trumpet shorter, not so narrow, mostly reticulate (fig. 178); paddle usually equally divided by midrib, sometimes large laterally (fig. 154) 8
8. Posterior corner of segment IV with large spine (fig. 155) *or* posterior margin of segment VIII with conspicuous lobes; paddle usually with accessory seta (fig. 154) .... *Psorophora*
   Segment IV without large spine on posterior corner; segment VIII without conspicuous lobes on posterior margin; paddle usually without accessory seta 9
9. Seta usually present on segment IX, located laterally or dorsolaterally in posterior corner of segment (fig. 151); setae 1 and 5 on segments IV-VI subequal in length (fig. 146); *or* paddle margin with long needlelike denticles (fig. 152) .... *Culiseta*
   Segment IX usually without seta, located ventrally when present; seta 5 much longer than 1 on segments IV-VI; paddle margin without long needlelike denticles .... *Aedes*

GENUS *AEDES* MEIGEN

Aedes Meigen, 1818, Syst. Beschr. zweifl. Ins. 1:13.
Type species: *Aedes cinereus* Meigen, 1818, by monotypy.

For complete synonymy, see Stone *et al.* (1959).

IMPORTANT REFERENCES: Knight, 1951 (*Aedes punctor* subgroup); Smith, 1958 (Key to females, New England); 1969a (Key to larvae, New England); Vockeroth, 1954a, 1954b (Canadian species); Zavortink, 1972 (revision of New World *Finlaya*).

The genus *Aedes* contains the largest number of species in New York, represented by 31 species in five subgenera. Of these, 16 are common throughout the State; some, such as *Aedes sticticus*, a floodwater species, can be locally abundant, and others are rare. Certain species from neighboring states and Canada have been included in the New York fauna since it is possible that they might occur in the State.

In New York State and the rest of the northeastern United States, species of the genus *Aedes* constitute the bulk of the mosquito nuisance, both in numbers of species and numbers of individuals which bite man. The New York species of *Aedes* can be classified in two of the 11 basic life cycle types described by Pratt (1959). Mosquitoes having the northern *Aedes* type of life cycle overwinter as eggs which are deposited singly on damp mud or earth and are univoltine. Many *Aedes* species occurring in northeastern United States exhibit this type of life cycle and are frequently referred to as "snowpool" mosquitoes because larvae are most often found in pools formed by melting snow or early spring rains. The "Temporary Pool" type of life cycle includes five groups based on the location of the breeding area: (a) salt marsh, (b) temporary pool or floodwater, (c) artificial container, (d) treehole and (e) rockpool groups. Species belonging to these groups overwinter as eggs deposited on damp earth, mud or the edge of a container, either natural or artificial, and are multivoltine.

From late spring through midsummer, the snowpool or "Northern *Aedes*" species are the primary nuisance species. Later in the summer until frost, the multibrooded floodwater species, *Aedes vexans*, is the major pest species in most areas of the State, and the multivoltine salt marsh species, *Aedes sollicitans*, on Long Island.

The females of most species of *Aedes* can be distinguished by one or more of the following characters: (1) distinctive scale patterns on the thoracic pleura; (2) the presence and nature of certain setae and bristles; (3) patterns and colors of scales on the mesonotum (scutum); (4) the presence and nature of bands of pale scales on the abdominal terga and legs. When scales are rubbed off a specimen, the color pattern of the integument of the mesonotum may be helpful for identification (Beckel, 1954). An especially useful method for separating some groups of *Aedes* is the presence or absence of scales in the postcoxal region (fig. 206). Even if a specimen is badly rubbed, these scales remain intact. Scales overhanging the top edge of the postcoxa from the propleuron may be mistaken for postcoxal scales, but do not extend over most of the area.

The first instar larvae of most species of *Aedes* may be distinguished by a combination of the following characteristics: (1) length of antennae; (2) length of terminal spines of antennae; (3) length or position of head hairs; (4) width of primary zone of sclerotization of the siphon relative to its length; (5) length and position of dorsal preapical spine.

With few exceptions, the species of second to fourth instar culicine mosquito larvae can be distinguished by one or a combination of the following characteristics: (1) length of antennae; (2) branching and positions of head hairs 5 (upper), 6 (lower) and 7 (preantennal); (3) relative lengths of prothoracic hairs 1–3; (4) number, shape and position of comb scales on eighth abdominal segment; (5) siphon index (length divided by width at base); (6) position of pecten teeth (evenly spaced or with apical teeth detached); (7) position and size of siphonal tuft; (8) length of dorsal preapical spine relative to apical pecten tooth; (9) whether saddle of anal segment is complete or incomplete; (10) length and branching of lateral hair of saddle; (11) length of gills (variable within a species).

Many of the identifying characters for determining species of *Aedes* pupae are variable, but most species may be determined by using a combination of the following characters: (1) degree of reticulation between float hairs on abdominal segment I; (2) size, position and branching of abdominal setae 1–9 on various segments; (3) length of respiratory trumpet relative to its pinna; (4) shape and nature of margin of paddle (denticulate, smooth).

DIAGNOSIS

FIRST INSTAR LARVA—HEAD: Rounded or subtriangular, wider than long; head hairs simple. Egg burster a median conical point in a dark disc which is surrounded by a membranous ring and connected posteriorly to the rest of the head capsule by a narrow sclerotized band; antennae variable in length, usually spiculate; antennal hair 1- to 3-branched; terminal spines of antenna less than half as long as shaft. **THORAX:** Prothoracic hairs 1–3 simple, not arising from a platelet and without prominent trichopores. **ABDOMEN:** Segments I–VI with two pairs of simple hairs having sparse branchlets, decreasing in length from segment I to segment VI, the upper hair longer than the lower; comb of eighth segment with 3–10 scales; pentad hairs usually simple, usually arranged more or less equally in an arc. **SIPHON:** Sclerotized area on apical half or less, consisting of a primary zone and a secondary zone; pecten with 3–11 spines (teeth); ventrolateral hair usually simple, inserted within or beyond pecten. **ANAL SEGMENT:** Longer than wide, with a small dorsal saddle; lateral hair usually simple; gills variable.

SECOND, THIRD AND FOURTH INSTAR LARVA—Unless otherwise stated under species diagnosis, fourth instar *Aedes* larvae have the following characteristics. Additional characteristics may be described for a particular species if they are unusual and serve to distinguish that species from other similar species. **HEAD:** Antenna shorter than head, spiculate, with one long and three shorter terminal setae; antennal tuft multiple, inserted near middle of shaft; branching and relative positions of head hairs 5 (upper), 6 (lower) and 7 (preantennal) varying with species. **THORAX:** Branching and relative lengths of prothoracic hairs 1 to 3 variable, with number 1 usually long, single and numbers 2 and 3 usually short, single to triple. **ABDOMEN:** Lateral abdominal hairs 1 and 6 varying in length and branching with the species, usually subequal on all segments, single to triple; comb scales of eighth segment variable in number, position and size, blunt or thornlike, with or without lateral spinules. **SIPHON:** Elongate; pecten with a variable number of teeth, evenly spaced or with one to three apical teeth detached, usually not extending beyond middle of siphon; siphonal tuft usually branched, inserted beyond pecten, individual hairs usually as long as width of siphon at point of insertion; dorsal preapical spine usually shorter than apical pecten teeth. **ANAL SEGMENT:** Saddle either complete or incomplete (sometimes meeting or almost meeting ventrally, but not completely fused); lateral hair of saddle usually single, length variable; dorsal brush usually consisting bilaterally of a long, single, lower hair and a multiple upper hair; gills variable, length ranging from budlike to 2–3 times as long as saddle or longer; ventral brush usually well developed, sometimes with one or more precratal tufts (tufts inserted anterior to the barred area bearing the cratal tufts).

ADULT—HEAD: Proboscis and palpi usually mostly dark-scaled, presence of light scales varying with the species; palpi of female about one-fourth the length of proboscis, of male usually as long as the proboscis (very short in subgenus *Aedes*); antennae of female with sparse whorls of setae, segments subequal in length; antennae of male densely plumose, last two segments elongate; occiput with narrow curved or lanceolate decumbent scales and erect forked scales dorsally, broad appressed scales laterally, sometimes extending along anterior margin; color pattern of occiput varying with the species; color of integument and presence or absence of scales and/or setae on torus varying with species. **THORAX:** Scale patterns and colors on scutum varying with species; mesonotal bristles well developed, varying in size and number with the species; pleura usually with well-developed patches of yellowish, dingy-white or silvery-white scales, the extent of these scale patches commonly used in species determinations; spiracular bristles absent; postspiracular bristles present; prealar, sternopleural and upper mesepimeral bristles numerous; lower mesepimeral bristles present or absent, the number of these bristles often used in species determinations. **ABDOMEN:** Terga with varying patterns of pale and dark scales, usually either dark-scaled or with basal bands of pale scales; tip of abdomen more or less pointed, segment VIII retractile. **LEGS:** Usually primarily dark-scaled, with varying degrees and patterns of pale scales; tarsal claw usually well developed, with an accessory tooth, the shape of the tarsal claw and tooth sometimes used to differentiate similar species. **WINGS:** Without distinct patch of setae at base of costa on underside; with varying patterns of light and dark scales on veins, scales either narrow or broad; second marginal cell R_2 much longer than its petiole (vein R_{2+3}). **MALE TERMINALIA:** Most male *Aedes* can be determined using key characters given for females, but for positive identification, characteristics of the terminalia are more reliable. The terminalia of *Aedes* are distinctive in the subgenera; their diagnostic characteristics are discussed under the appropriate subgeneric headings.

PUPA—CEPHALOTHORAX: Respiratory trumpet usually short, with little tracheoid portion, widened apically. **ABDOMEN:** Float hair of tergite I well developed, dendritic; seta 9 of segments II–VI usually minute, simple; seta 9 prominent on segments VII and VIII; seta 5 shorter than 3 on segment II; seta 4 longer than 1 on segments IV–VI; seta 2 usually single, thornlike on segments II–VIII; segment IX usually without a seta, but, if present, located ventrally; paddle divided evenly by midrib, marginal denticulation varying; terminal seta of paddle present, accessory seta absent.

IMPORTANCE AND DISEASE RELATIONSHIP

The California Group Encephalitis viruses have been isolated from at least 17 New York species of *Aedes*, with seven strains isolated from *A. vexans*, one of the major pest species in the State (Sudia *et al.*, 1971; Margaret Grayson and Jack Woodall, Division of Laboratories and Research, New York State Health Department, pers. comm., 1975). Eight of nine species from which California Group viruses have been isolated by the New York State Health Department since 1965 were species of *Aedes*.

Other arboviruses, including Eastern Encephalitis, St. Louis Encephalitis, Cache Valley and Flanders viruses have also been isolated from several species of *Aedes* mosquitoes which occur in New York. When wooden sailing ships were in use, *Aedes aegypti*, the Yellow Fever mosquito, was a threat to the residents of New York. This species occurs in New York only occasionally now and is not known to overwinter in the State, but it could conceivably transmit the Yellow Fever virus to residents if conditions were suitable.

In addition to viruses, *Dirofilaria immitis*, a filarial parasite causing heartworm in dogs, has become widespread in New York and is largely transmitted by species of *Aedes*.

Aside from the disease relationship, most species of *Aedes* contribute largely to the mosquito nuisance in New York. On Long Island, *Aedes sollicitans* has been a major problem affecting the habitability and usefulness of many shore areas for many years. In the mountains, several species of *Aedes* which breed in snowmelt pools make up the bulk of the mosquito nuisance and are partly responsible for limiting tourism. Throughout the State, including the urban areas, *Aedes vexans* is probably the most common nuisance mosquito species in late summer, often entering houses in large numbers to feed at night and preventing many outside evening activities.

KEYS TO SPECIES OF THE GENUS *AEDES*

FIRST INSTAR LARVAE*

1. Antennae glabrous, without spicules (fig. 35) .... *triseriatus*

Antennae with spicules arranged in short transverse rows (fig. 49) 2

Antennae with spicules scattered, not arranged in transverse rows (fig. 53) 3

2. Gills subequal; antennal hair fine, 2- or 3-branched (figs. 50, 51) .... *trivittatus* (pars)

Ventral pair of gills shorter than dorsal pair; antennal hair stout, simple or bifurcate (figs. 48, 49) .... *atlanticus*

3. Antennae with one long and two short terminal spines (fig. 53) 4

Antennae with two long subequal and one short terminal spine (fig. 60) 7

Antennae with three long subequal spines (figs. 64, 73c) 15

4. Primary zone of sclerotization about 2.5 times longer than wide (fig. 52) .... *fitchii*

Primary zone of sclerotization one-half to one times as long as wide (fig. 54) ... *taeniorhynchus*

Primary zone of sclerotization less than half as long as wide (figs. 34, 56) 5

5. Dorsal preapical spine beyond middle of primary zone of sclerotization (fig. 50) .... *trivittatus* (pars)

Dorsal preapical spine at middle of primary zone of sclerotization (fig. 34) 6

6. Outer occipital hair (9) double (fig. 57)... *aegypti*

Outer occipital hair (9) simple (fig. 58) .... *atropalpus*

7. Primary zone of sclerotization about half as long as wide (fig. 55) 8

Primary zone about two-thirds as long as wide (fig. 62) .... *communis* (pars)

Primary zone about as long as wide (fig. 62) ...9

8. Upper and lower head hairs 5 and 6 and postclypeal hair (4) in nearly straight transverse line (fig. 59) .... *sticticus*

Head hairs 4, 5 and 6 not in transverse line (fig. 51) .... *trivittatus* (pars)

9. Siphon hair inserted within pecten 10

Siphon hair inserted beyond pecten 11

10. One pecten tooth beyond siphon hair (fig. 68) .... *intrudens*

Three to five pecten teeth beyond siphon hair (fig. 67) .... *trichurus*

11. Dorsal preapical spine within basal one-fourth of primary zone of sclerotization (fig. 61) .... *mitchellae*

Dorsal preapical spine at basal one-third of primary zone of sclerotization (fig. 70) 12

Dorsal preapical spine at about middle of primary zone of sclerotization (fig. 69) 13

Dorsal preapical spine at apical one-third of primary zone of sclerotization ..... *punctor* (pars)

12. Primary zone of sclerotization longer than wide; comb scales nine to ten; pecten teeth seven to eight .... *communis* (pars)

Primary zone of sclerotization shorter than wide; comb scales and pecten teeth three to six (fig. 70) .... *sollicitans*

13. Pentad hair 3 subequal to others ...... *implicatus*

Pentad hair 3 much longer than others (fig. 69) 14

14. Primary zone of sclerotization about as long as wide (fig. 69) .... *punctor* (pars)

Primary zone of sclerotization about one and one-fourth as long as wide (fig. 66) .... *hexondontus*

15. Siphon hair 2- or 3-branched (sometimes simple on one side), shorter than width of siphon at point of insertion (fig. 65) 16

Siphon hair simple, usually longer than width of siphon (fig. 72) 17

16. Distal pecten teeth composed of long primary spine and gradually decreasing series of shorter spines (fig. 65b) .... *cinereus*

Distal pecten teeth composed of long primary spine and group of small subbasal spines (fig. 71b) .... *vexans*

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* Adapted from Dodge (1966).

17. Primary zone of sclerotization about one third as long as wide (fig. 72) .... *dorsalis*
Primary zone about as long as wide (fig. 74) ... 18
Primary zone about twice as long as wide (fig. 73).......... *excrucians*

18. Comb scale thornlike with long terminal spine; dorsal preapical spine at apical third of primary zone (fig. 78) 19
Comb scale fringed apically, without terminal spine (fig. 74a) 20

19. Antenna three-fourths as long as head or longer (fig. 77) .... *diantaeus*
Antenna less than half as long as head (fig. 63) .... *flavescens*

20. Dorsal preapical spine at about basal third of primary zone; head capsule black (fig. 74) .... *canadensis*
Dorsal preapical spine at about apical third of primary zone; head capsule grey (fig. 75) 21

21. Head hairs longer than antennae (fig. 79) .... *thibaulti*
Head hairs shorter than antennae (fig. 76) .... *stimulans*

SECOND, THIRD AND FOURTH INSTAR LARVAE

1. Siphonal tuft inserted within pecten *or*, if opposite outer pecten tooth, comb scales short, blunt and fringed with apical spinules (figs. 92, 94); pecten with or without accessory subdorsal setae 2
Siphonal tuft inserted well beyond pecten *or*, if opposite outer pecten tooth, comb scales long and thornlike (fig. 91); siphon without subdorsal setae 3

2. Siphon with subdorsal setae; comb scales fewer than 20, individually thornlike; siphon index about 3.0 (fig. 94) .... *trichurus*
Siphon without subdorsal setae; comb with about 20–50 scales, each short, blunt, fringed apically with short spinules; siphon index usually much less than 3.0 (fig. 92) .... *atropalpus*

3. Ventral siphonal valves each with sickle-shaped hair about as long as the valve (fig. 91); siphon very long and slender, tapered to less than half basal width; siphon index 3.5 or more; seta 1 on abdominal segments IV and V long and erect, approximately as long as number 6 (fig. 95) 4
Siphonal valve hairs shorter than valve; siphon index variable; seta on abdominal segments IV and V usually less than half as long as number 6 5

4. Pecten with outer tooth or teeth longer than and somewhat separated from rest of pecten (fig. 93); setae 1 and 6 on abdominal segments IV, V and VII usually single (fig. 95) .... *excrucians*
Pecten teeth similar in size and spacing or increasing gradually from base (fig. 91); seta 1 on abdominal segments III–VII single or double; seta 6 usually double in fourth instar (fig. 96) .... *fitchii*

5. Antenna as long as or longer than head [may be slightly shorter in second and third instar with three long subequal setae and one short seta (fig. 98)]; siphonal tuft at least as long as width of siphon at point of insertion (fig. 97) ...6
Antenna no more than three-fourths as long as head *or*, if nearly as long, then with one long and three short terminal setae (fig. 106) *or*, siphonal tuft much shorter than width of siphon at point of insertion (fig. 132) 7

6. Head hair 6 lying distinctly in front of line between 5 and 7; antenna much longer than head in fourth instar, gradually darkened and tapered (fig. 98) .... *diantaeus*
Head hairs 5, 6 and 7 lying in straight line; antenna approximately as long as head, strongly curved, swollen and white to beyond tuft in fourth instar, less strongly swollen and shorter in second and third instar (fig. 100) .... *aurifer*

7. Dorsal brush of anal segment with long subequal hairs, without tuft of shorter hairs; comb scales usually four to eight in curved or irregular row, each scale thornlike and nearly as long as outer pecten teeth; saddle complete in fourth instar (fig. 99) .... *abserratus*
Dorsal brush of anal segment with one long hair and tuft of shorter hairs (fig. 101); comb scales and saddle variable 8

8. Pecten teeth nearly all similar in size and spacing or increasing gradually and regularly from base (fig. 101) 9
Outer pecten tooth or teeth distinctly longer or larger than, and separated from basal teeth (fig. 129) 29

9. Small hairs of body stellately branched (fig. 103); antenna smooth, without spicules, its tuft represented by single hair (fig. 104) 10
Small hairs of body single or double; not stellate, usually inconspicuous; antenna spiculate (fig. 106), its tuft with two or more branches 11

10. Ventral brush with six pairs of hairs; thorax and abdomen pigmented; anal gills tapering distally, dorsal longer than ventral; acus usually attached to siphon (fig. 105) .... *triseriatus*

Ventral brush with five pairs of hairs; thorax and abdomen without pigment; anal gills sausage-shaped, dorsal and ventral subequal in length; acus usually detached (fig. 102) .... *hendersoni*

11. Pecten index less than 0.5; siphonal tuft at least three-fourths as long as pecten, inserted at or before middle of siphon; saddle hair at least two-thirds as long as saddle (fig. 101) 12
Pecten index at least 0.5, *or* siphonal tuft less than three-fourths as long as pecten, *or* siphonal tuft inserted beyond middle of siphon, *or* saddle hair less than two-thirds as long as saddle 24

12. Head hairs 5 and 6 normally all branched, number 6 with 3 or more branches 13
Head hairs 5 and 6 normally single in second and third instars, single or with branches in fourth instar (rarely more) 16

13. Antenna nearly as long as head, siphon index 4.5–5.0 (fig. 101) ....*thibaulti*
Antenna about one-half to two-thirds as long as head, siphon index 4.0 or less 14

14. Dorsal preapical spine less than half as long as apical pecten tooth (fig. 123) ....*flavescens* (pars)
Dorsal preapical spine two-thirds as long as pecten tooth or longer (fig. 107) 15

15. Gills as long as or longer than saddle, pointed, (easily detached); siphon index 3.0–4.0 in fourth instar; prothoracic hairs 1 and 5 rarely branched; mesothoracic hair 1 weak, shorter than number 3, or head hairs 5 and 6, much shorter than antenna (figs. 106–108); [larvae common throughout the State in fresh water] ... . *canadensis*
Gills usually shorter than saddle and budlike (fig. 109) (occasionally elongate in fresh water); prothoracic hairs 1 and 5 usually branched in IV; mesothoracic hair 1 well developed, longer than number 3 or head hairs 5 and 6, subequal to antenna (fig. 110); [salt marsh species, common in brackish and fresh water coastal pools and brackish pools inland] ....*cantator*

16. Comb scales usually 15 or less (rarely 20–22) in an irregular single or double row, each scale thornlike and nearly as long as outer pecten tooth (figs. 118, 120, 121); saddle variable 17
Comb scales more than 15 (at least in IV), usually many more, arranged in a more or less triangular patch; saddle incomplete in IV 20

17. Prothoracic hairs 1–3 long, subequal (fig. 119); lateral hair of saddle at least as long as saddle (fig. 118) 18
Prothoracic hairs 1–3 distinctly different lengths (fig. 116); lateral hair of saddle shorter than saddle 19

18. Comb usually with 10 or more scales (occasionally as few as six), individual scale usually less than 1 mm in length with large terminal spine about same length as base (fig. 120a); prothoracic hair 5 usually single (fig. 119); [common species, especially at higher elevations] ....*punctor*
Comb with nine or fewer scales (usually five to six), individual scale usually at least 1.1 mm., with terminal spine about 1.5 times as long as base (fig. 120b); prothoracic hair 5 usually double or triple; [not reported from New York] ....*hexodontus*

19. Comb usually with four to six scales; head hair 7 usually 7- to 9-branched; dorsal pair of anal gills longer than ventral pair; saddle complete in fourth instar; siphon index about 2.0 (fig. 115) ....*atlanticus*
Comb usually with 8–16 scales; head hair 7 usually 3- to 4-branched; anal gills subequal in length; saddle incomplete; siphon index about 3.0; [not reported from New York] ....*impiger*

20. Saddle smooth or with a few strong spinules surpassing apical margin (fig. 111) 21
Saddle conspicuously roughened apically, with numerous strong spinules surpassing apical margin (fig. 124) 23

21. Head hair 5 with three or four branches; number 6 double or triple ......*flavescens* (pars)
Head hairs 5 and 6 normally single 22

22. Comb scales numerous and overlapping (30 to more than 70 in fourth instar); base of comb scale shorter than apical portion (fig. 114); head capsule light brown with contrastingly dark sutures (fig. 112) ....*communis*
Comb scales well separated and distinct (15 to about 30 in third and fourth instars); base of comb scale larger than apical portion (fig. 117); head capsule dark brown ....*implicatus*

23. Head hair 6 single (rarely double); abdominal hair 1 of segments IV and V less than half as long as abdominal hair 6; [common species throughout the State] (figs. 126, 127) ....*stimulans*
Head hair 6 usually double; abdominal hair 1 of segments IV and V nearly as long as hair 6; [southern species, rare in New York] (figs. 124, 125) ....*grossbecki*

24. Saddle complete in fourth instar; dorsal preapical spine variable, but if shorter than apical pecten tooth, then siphon index about 2.0 25

Saddle incomplete in fourth instar; dorsal preapical spine shorter than apical pecten tooth (fig. 128); siphon index 2.5–3.0 28

25. Siphon index 3.0 or more; pecten index 0.5 or less; dorsal preapical spine as long as apical pecten tooth (fig. 122) .... *mitchellae*

Siphon index 2.5 or less; pecten index 0.45 or more; dorsal preapical spine variable 26

26. Gills shorter than saddle, budlike (fig. 139); dorsal preapical spine as long as apical pecten tooth; [brackish water species] 27

Gills twice as long as saddle or longer; dorsal preapical spine shorter than apical pecten tooth; [fresh water species] (fig. 141) .... *trivittatus*

27. Saddle conspicuously roughened apically with numerous strong spinules surpassing caudal margin (fig. 140); siphon index usually less than the 2.0; comb scale apically fringed with subequal spinules; [southern salt marsh species, rare in New York] .... *taeniorhynchus*

Saddle relatively smooth without strong spinules surpassing caudal margin; siphon index 2.5–3.0; comb scale with a long central spine (fig. 139); [common salt marsh species] .... *sollicitans*

28. Gills longer than saddle, pointed; comb scale with long terminal spine; saddle nearly meeting ventrally in fourth instar (fig. 128); head hairs 5 and 6 single or double in second and third instars, with two to five branches; [locally abundant flood water species] .... *sticticus*

Gills usually shorter than saddle, budlike; comb scale fringed apically; sides of saddle not approaching ventrally (fig. 130); head hairs 5 and 6 usually single, rarely branched; [larvae in fresh or brackish water] .... *dorsalis*

29. Siphon tuft well developed and distinct, at least three-fourths as long as width of siphon at point of insertion, frequently inserted near or opposite distal pecten tooth (fig. 129); saddle hair rarely branched 30

Siphonal tuft delicate and inconspicuous, usually not more than half as long as width of siphon at point of insertion, inserted well beyond pecten teeth (fig. 132); saddle hair branched 35

30. Comb with 20–36 scales in patch .... *flavescens* (pars)

Comb with fewer than 20 scales 31

31. Antennae more than half as long as head 32

Antennae no more than half as long as head; [rare, if occurring at all in New York] 33

32. Comb scales 9–18 in irregular patch (fig. 129); [common woodland species] .... *intrudens*

Comb scales five to seven in single or irregular row (fig. 131); [rare in New York] .... *decticus*

33. Head hairs 5 and 6 branched; siphon index 3–4 34

Head hairs 5 and 6 single (rarely double), siphon index 2–2.5 .... *spencerii*

34. Pecten extending well beyond middle of siphon, usually with three or four detached teeth; comb with 12–18 scales; dorsal brush with 8–12 hairs (fig. 138) .... *barri*

Pecten not extending beyond middle of siphon, with two to three detached teeth; comb with six to eight scales; upper caudal tuft of dorsal brush with four to six hairs (fig. 136) .... *riparius*

35. Head hairs 5, 6 and 7 inserted in straight line (fig. 134); abdominal hair 6 on segments III–V single .... *cinereus*

Head hair 6 inserted anterior to line between hairs 5 and 7 (fig. 135); abdominal hair 6 on segments IV and V double or triple in third and fourth instars .... *vexans*

FEMALES

1. Some tarsal segments with basal and sometimes apical rings of pale scales (fig. 226) 2

Tarsal segments without white rings 16

2. Proboscis with distinct ring of pale scales near middle (rarely reduced) (fig. 230); metameron bare 3

Proboscis without distinct pale ring, but sometimes with scattered pale scales; metameron with or without pale scales 5

3. Hind basitarsus with median ring of yellowish scales (fig. 228); wing veins with many scattered pale scales (fig. 257); dorsum of abdomen usually with a longitudinal stripe of yellowish scales (fig. 234) .... *sollicitans*

Pale scales not forming complete median ring on hind basitarsus; wing without pale scales or with pale scales at base of costa only; small- to medium-sized dark species with sharply contrasting white scale patches 4

4. Abdomen with mid-dorsal patches of pale scales, often forming continuous stripe (fig. 230); femora speckled anteriorly with numerous pale scales .... *mitchellae*

Dorsal surface of abdomen with pale basal bands, but without mid-dorsal patches of pale scales (fig. 232); femora mostly dark-scaled anteriorly .... *taeniorhynchus*

5. Tarsi with pale rings at both ends of some segments (fig. 226) 6

Tarsi with pale rings at bases of segments only (fig. 227) 8

6. Wing veins with pale scales more numerous than dark ones (fig. 255); pleural scale patches extensive and confluent; postcoxal area, hypostigial area and metameron with pale scales ....*dorsalis*

Wing veins dark or with pale scales confined to base of costa; pleural scale patches reduced and separate; postcoxal area, hypostigial area and metameron without pale scales 7

7. Costa with pale scales at base (fig. 254); mesonotum with a broad median stripe or pair of stripes of black scales (fig. 241) ....*atropalpus*

Costa dark-scaled at base; mesonotum with reddish-brown to dark-brown scales, often with indications of submedian lines of pale scales (fig. 242) ....*canadensis*

8. Pale rings of hind tarsi short, usually not more than 3 times as long as wide (fig. 227); postcoxal area bare 9

Pale rings of at least some hind tarsal segments more than 3 times as long as wide (fig. 229); postcoxal area with pale scales 10

9. Lower mesepimeral setae absent; metameron bare; pale bands on abdominal tergites 3, 4 and 5 each with V-shaped notch posteriorly; segment VII mostly dark-scaled (fig. 235) ....*vexans*

Lower mesepimeral setae present; metameron with pale scales; pale bands without V-shaped notch; segment VII almost entirely pale-scaled (fig. 236) ....*cantator*

10. Most dorsal wing scales broad, only about twice as long as wide; pale scales numerous, extending to posterior fringe; with contrasting white and dark scales (fig. 259); large species ... .*grossbecki*

Wing scales long, at least three times as long as wide, pale scales usually absent or reduced in number on posterior margin of wing 11

11. Accessory tooth of tarsal claw nearly parallel to primary tooth and usually longer than distance between its apex and apex of primary tooth (fig. 260a); lower mesepimeral setae usually absent ....*excrucians*

Accessory tooth of tarsal claw short and divergent, not longer than distance between its apex and apex of primary tooth (fig. 260b); lower mesepimeral setae present or absent 12

12. Tarsal claw strongly arched; accessory tooth slender, about as long as distance between its apex and apex of primary tooth (fig. 260b); abdominal terga usually with distinct basal bands 13

Tarsal claw straight with curved tip; accessory tooth short and blunt, usually much shorter than distance between its apex and apex of primary tooth (fig. 260c); abdominal terga either entirely covered with pale scales or with distinct or indistinct banding and scattered pale scales 14

13. Lower mesepimeral setae from none to two, rarely three or four; pale scales of wings usually numerous; torus usually pale-scaled; (not always separable from *A. stimulans*) ....*fitchii*

Lower mesepimeral setae usually three or more; pale scales on wings usually few in number, located mostly on anterior veins; torus usually without pale scales; (not always separable from *A. fitchii*) ....*stimulans*

14. Abdominal terga densely covered with overlapping yellow and light brown scales, sometimes with a few black scales forming thin median longitudinal stripe; without pale basal bands (fig. 240) ....*flavescens*

Abdominal terga with few to many scattered yellowish or whitish scales, dark (light brown) scales on most terga more numerous than pale scales; with or without pale basal bands 15

15. Scutum reddish brown, without white markings; abdominal terga with many scattered yellowish scales, without basal bands ....*riparius*

Scutum clothed with coppery scales, with white half-stripes and spots; abdominal terga with basal white bands and few scattered whitish scales (fig. 239) ....*barri*

16. Scutum with one or two broad median or submedian stripes of pale scales (fig. 244) 17

Scutum without such stripes of pale scales 18

17. Scutum with two submedian stripes of whitish or yellowish scales separated by three subequal dark-brown stripes (fig. 245) ....*trivittatus*

Scutum with single broad median stripe of white scales bounded by dark-brown scales (fig. 244) ....*atlanticus*

18. Wing veins alternating black- and white-scaled (fig. 258) ....*spencerii*

Wing veins all dark-scaled *or* with white scale patches only at bases of veins *or* with scattered pale scales on anterior veins 19

19. Postcoxal area and metameron with pale scales; lower mesepimeral setae usually present 20

Postcoxal area without scales; metameron with or without scales; lower mesepimeral setae absent in most species 25

20. Scutum with many long black setae, thus having hairy appearance; postpronotum with black setae scattered over posterior half; integument

usually very dark; legs without knee spots; [not reported from New York] .... *impiger*
Scutum usually without long dark setae; if present, legs with knee spots (fig. 252); postpronotum with setae in single or irregular double row on posterior margin; integument light brown 21

21. Pleural scale patches reduced, extending only halfway to propleuron; legs with knee spots .... *implicatus*
Pleural scale patches extensive and confluent (but easily rubbed off) extending to propleural patch and to lower margin of mesepimeron; legs with or without knee spots 22

22. Base of costa, and usually of other veins, as well as torus and hypostigial area, with many pale scales; pale scales on pleura and sides of mesonotum very extensive; without distinct knee spots; large species .... *trichurus*
Wing veins with few, if any, basal white scales (except *hexodontus*); hypostigial area without scales; legs with distinct knee spots; medium-sized species 23

23. Scutum usually with distinct median stripe or stripes of coppery- to dark-brown scales, yellowish to reddish sides (fig. 243); base of costa frequently with a few pale scales; [not always separable from *abserratus* or *hexodontus*] .... *punctor*
Mesonotum usually uniformly covered with minute coppery scales, occasionally with faint stripes of scales darker than yellowish sides; costa with or without basal white scale patch; [not always separable from *punctor*] 24

24. Base of costa (and other veins) with patch of white scales (fig. 256) .... *hexodontus*
Costa and other veins dark-scaled only .... *abserratus*

25. Pale basal bands of abdominal tergites narrowed or absent mid-dorsally (rarely well developed) *and* scutum with distinct stripe or stripes of dark scales (fig. 238); sternopleural and propleural scale patches widely separated 26
Pale basal bands of abdomen distinct and rarely much narrowed mid-dorsally; scutum with or without dark stripes; if present, sternopleural scale patch reaching anteriorly to propleural scale patch and metameron with pale scales 31

26. Scutum with broad stripe of very dark scales widened posteriorly (occasionally divided medially with line of pale-yellow scales (fig. 251); sides with silvery-white or golden-yellow scales 27
Scutum with narrow stripe or pair of stripes of dark-brown scales (fig. 248); sides pale yellowish or with dark stripes 30

27. Abdominal sternites entirely pale-scaled or with scattered brown scales, without apical bands; forecoxae usually with patches of dark scales (fig. 250b); anterior margin of scutum, costa and subscosta without pale scales .... *aurifer*
At least some abdominal sternites with apical bands of dark scales; forecoxae with pale or golden scales only; anterior margin of scutum and sometimes bases of costa and subcosta with pale scales 28

28. Sides of mesonotum and postpronotum with broad, silvery-white scales (fig. 252b); pleura with dense, well-defined patches of silvery-white scales 29
Sides of mesonotum and postpronotum with narrow, golden scales (fig. 252a); pleura with small, well-defined patches of grayish-white scales .... *thibaulti*

29. Base of costa completely dark-scaled or with few pale scales; mesonotum with few, weakly developed bristles anteriorly (fig. 249) .... *triseriatus*
Base of costa with a patch of white scales; mesonotum with many well-developed bristles anteriorly (fig. 247) .... *hendersoni*

30. Occiput and postpronotum with dark appressed scales; metameron without scales; sternopleuron with 10 or fewer setae .... *decticus*
Occiput with pale-yellowish scales only; postpronotum rarely with dark scales; metameron usually with few pale scales; sternopleuron with 12–20 setae .... *diantaeus*

31. Pleural scale patches extensive and confluent, reaching anteriorly along upper margin of sternopleural scale patch, and on mesepimeron to lower anterior angle; lower mesepimeral setae stout .... *communis*
One or both pleural scale patches reduced, not reaching lower margin of mesepimeron or (except in some *sticticus*) propleural scale patch; with or without lower mesepimeral setae 32

32. Forecoxae with patches of flat dark scales (fig. 250a); metameron without scales; torus and base of costa with dark scales only; small species .... *cinereus*
Forecoxae with pale scales only; metameron with at least few pale scales; torus and base of costa frequently pale-scaled 33

33. Scutum with median stripe or stripes (sometimes indefinite) of fine golden- to dark-brown scales, with posterior half stripes and large

postpronotal patches of same color (fig. 246); lower mesepimeral setae usually absent .... *sticticus*
Scutum and postpronotum uniformly covered with rough brownish-yellow scales, rarely with median stripes of dark scales; lower mesepimeral setae usually present ....*intrudens*

MALES

1. Dististyle arising before apex of basistyle; apex of basistyle cone-shaped (fig. 273); (subgenus *Aedes*) ....*cinereus*
Dististyle arising at apex of basistyle 2
2. Dististyle wide apically, with terminal projection nearly as long as terminal spine (fig. 274); (subgenus *Aedimorphus*) ....*vexans*
Dististyle narrow, with terminal spine only at apex 3
3. Claspette absent (fig. 271); (subgenus *Stegomyia*) ....*aegypti*
Claspette present 4
4. Apical claw of dististyle about half as long as dististyle; apical and basal lobes of basistyle absent; basistyle with dense median brush of setae (fig. 275); (subgenus *Protomacleaya*) 5
Apical claw of dististyle not more than one-third as long as dististyle; basal lobes present, sometimes represented by a swelling bearing a brush of setae; apical lobes present or absent; basistyle usually without a median brush of setae (fig. 272); (subgenus *Ochlerotatus*) 6
5. Tergal surface of basistyle constricted at level of claspette filament; median tuft of basistyle strongly developed with sharply curved setae (fig. 276) ....*hendersoni*
Tergal surface of basistyle not constricted; median tuft of basistyle moderately developed, with no, or very few, sharply curved setae (fig. 275) ....*triseriatus*
6. Basistyle with dense brushlike median tuft of long setae (fig. 277) 7
Basistyle without dense brushlike median tuft or long setae 8
7. Apical lobe of basistyle elongate; lobes of ninth tergite narrow, each bearing four or five stout spines (fig. 278) ....*decticus*
Apical lobe of basistyle broadly rounded; lobes of ninth tergite broad, each bearing 10–12 or more stout spines (fig. 277) ....*diantaeus*
8. Basistyle without apical lobe; basal lobe with brush of hairs (fig. 272) 9
Basistyle with apical lobe; basal lobe variable ... .12
9. Claspette filament about half as long as stem (fig. 272) ....*atropalpus*
Claspette filament about as long as stem 10
10. Claspette filament with sharp thornlike projection medially (fig. 278) ....*taeniorhynchus*
Claspette filament simple, without projection ... .11
11. Basal lobe protruding distinctly, basistyle widened at basal lobe (fig. 279) ....*mitchellae*
Basal lobe protruding only slightly; basistyle not distinctly widened at basal lobe (fig. 283) .... *sollicitans*
12. Stem of claspette branched, one branch bearing filament, other branch bearing seta; claspette filament enlarged and irregularly shaped (fig. 282) ....*thibaulti*
Stem of claspette unbranched, bearing filament only; filament not enlarged and irregularly shaped 13
13. Basistyle with conspicuous dense brush of long setae apically (fig. 281) 14
Basistyle without dense apical brush of long setae 15
14. Claspette filament with large barblike median projection on convex side; basal lobe bearing single, long, stout seta at apex (fig. 281) ....*aurifer*
Claspette filament with median *angular* expansion on convex side, not barblike; basal lobe bearing two stout setae at apex and one at base (fig. 284) ....*intrudens*
15. Basal lobe with two long, stout setae at apex (fig. 285) ....*trichurus*
Basal lobe without such apical setae 16
16. Basal lobe with a single, large, stout spine on an elongate fingerlike process (fig. 286) ....*atlanticus*
Stout spine of basal lobe absent or not on an elongate process 17
17. Apical lobe with large patch of spatulate setae (fig. 287) ....*canadensis*
Apical lobe without spatulate setae 18
18. Basal lobe with two stout spines and several small hairs (fig. 288)..........................*dorsalis*
Basal lobe with one or no stout spines, some hairs on basal lobe often quite long 19
19. Basal lobe narrowly joined to basistyle, sometimes appearing almost detached (fig. 289) 20
Basal lobe broadly joined to basistyle (fig. 291) 21
20. Claspette filament broad, its lower basal corner forming an angle with claspette stem (fig. 290) ....*spencerii*
Lower basal corner of claspette filament continuous with claspette stem, not forming an

angle (fig. 289) ....*sticticus*

21. Basal lobe without stout spine, with many short hairs (fig. 291) ....*excrucians*
Basal lobe with conspicuous stout spine or group of long hairs (fig. 292) 22
22. Claspette filament with barblike projection medially (fig. 292) ....*trivittatus*
Claspette filament without barblike projection, sometimes with sharp corner medially 23
23. Basal lobe covered with numerous short hairs, not knoblike (fig. 293) 24
Basal lobe represented as knoblike projection from basistyle (fig. 295) 25
24. Basal lobe area long, triangular, without membranous area within basal lobe (fig. 294) ....
....*flavescens*
Basal lobe area short, more rounded than in *flavescens*, projecting somewhat basally, with small, oval, membraneous area immediately above stout spine (fig. 293) ....*stimulans*
25. Claspette filament with narrow, elongate, necklike base (fig. 295) 26
Claspette filament broadly joined to stem or with short constriction (fig. 297) 27
26. Basal lobe long, conical, bearing small apical setae and stout dorsal spine (fig. 295) ....
....*grossbecki*
Basal lobe short, bluntly rounded, bearing two or three long setae, many short setae and stout dorsal spine (fig. 296) ....*cantator*
27. Basal lobe with membranous hair-bearing portion hidden in ventral view behind projecting ventral shoulder; projecting lobe narrow, bluntly rounded with long fine setae (fig. 297)
....*abserratus*
Basal lobe with membranous hair-bearing portion well exposed in ventral aspect, without projecting ventral shoulder; projecting lobe broadly rounded with short heavy setae or subquadrate with fine setae 28
28. Claspette filament sharply bent, forming right angle with stem (fig. 300) ....*communis*
Claspette filament not sharply bent, forming obtuse angle with stem 29
29. Claspette filament roundly expanded near base on convex side (fig. 298) ....*riparius*
Claspette filament uniformly curved on convex side 30
30. Basal lobe with numerous long, fine setae forming dense brush; apical lobe with few long hairs on mesal surface (fig. 301) ....*fitchii*
Basal lobe with few rather short setae; apical lobe with many setae on mesal surface (fig. 299)
....*punctor*

PUPAE *

(For usual positions of setae, see plate XXIII.)

1. Seta 9 on segments II–VI well developed, rather stout (fig. 165); cephalothoracic seta 6 long and stout (fig. 166); seta IV-4 usually double ....*aegypti*
Seta 9 on segments II–VI minute, not well developed; cephalothoracic seta 6 short to medium; seta IV-4 usually with three or more branches (fig. 143) 2
2. Seta VII-4 short, usually 3- to 5-branched (fig. 168) 3
Seta VII-4 medium to long, usually single or double 5
3. Respiratory trumpet usually not more than 4 times as long as its pinna (fig. 180); seta II-6 usually with two to four branches, posterior to seta II-9; seta VIII-4 single 4
Respiratory trumpet usually 6–7 times as long as its pinna (fig. 181); seta II-6 single, anterior to seta II-9; seta VIII-4 with two to four branches ....*atlanticus*
4. Paddle at least as wide as long, apex emarginate, margin smooth (fig. 163); seta II-1 with less than 10 branches ....*atropalpus*
Paddle longer than wide, apex rounded, margin partially denticulate (fig. 161); seta II-1 with more than 10 branches ....*trivittatus*
5. Respiratory trumpet approximately 3 times as long as its pinna (fig. 182) ....*taeniorhynchus*
Trumpet at least 5 times as long as its pinna (fig. 183) 6
6. Seta 1 on segments III–VI and seta III-5 single
....*trichurus*
Seta 1 on segments III–VI and seta III-5 usually at least double 7
7. Seta 1 on segments III–VII not more than half the length of following tergum; seta V-4 usually single 8
Seta 1 on segments III–VI usually much more than half the length of following tergum; seta V-4 usually double or triple 10
8. Reticulation between float hairs present; seta II-3 approximately half as long as tergum II (fig. 169); seta VIII-9 with less than 4 branches ....
....*decticus*
Reticulation between float hairs absent; seta II-3 approximately as long as tergum II (fig. 170); seta VIII-9 with four or more branches 9
9. Seta IV-1 usually 4- to 5-branched; seta IV-5 usually more than 1.5 times as long as seta III-3
....*hendersoni*

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* (Adapted from Darsie, 1957; Reinert, 1971; Zavortink, 1972).

Seta IV-1 usually 2- to 3-branched; seta IV-5 usually less than 1.5 times as long as seta III-3 (fig. 170) .... *triseriatus*

10. Seta 4 on segments II–VI usually all single; seta VIII-9 single, rarely double; seta VII-9 single .... *cinereus*
Seta 4 on segments II–VI never all single; seta 9 on segments VII and VIII usually at least double 11

11. Seta IV-1, V-1 and IV-6 usually with at least three branches; seta II-3 usually 4- or 5-branched 12
Seta IV-1, V-1 and IV-6 usually single or double; seta II-3 usually double or triple 17

12. Lines of reticulation between float hairs strong; seta II-1 usually 5- or 6-branched 13
Lines of reticulation between float hairs light or absent; seta II-1 usually 11-branched 16

13. Setae IV-4 and VI-1 usually 3- to 6-branched metathoracic seta 10 usually with six or more branches .... *aurifer*
Setae IV-4 and VI-1 usually double, rarely triple; metathoracic seta 10 usually with less than six branches 14

14. Metathoracic seta 11 single, rarely double; seta II-7 usually triple; respiratory trumpet 7–8 times as long as its pinna (fig. 144) ....*fitchii*
Metathoracic seta 11 double, rarely single; seta I-5 with three or more branches; seta II-7 usually double; trumpet about 6 times as long as its pinna (fig. 184) 15

15. Seta VII-1 usually with two or more branches; seta VII-5 double; seta II-4 usually triple (fig. 192) .... *excrucians*
Seta VII-1 single, rarely double; seta VII-5 usually triple; seta II-4 usually double ......*riparius*

16. Seta I-4 single; seta VII-5 usually 4-branched; seta VII-6 usually triple (fig. 192); paddle margin mostly smooth (fig. 162); setae 1 and 4 on segments IV–VI usually not as long as following tergum .... *vexans*
Seta I-4 double or triple; seta VII-5 usually double; seta VII-6 usually 8-branched (fig. 194); paddle margin denticulate (fig. 164); setae 1 and 4 on segments IV–VI longer than following tergum .... *cantator*

17. Setae I-6 and II-3 usually 2- to 4-branched; seta I-7 usually longer than I-6 (fig. 195) .... *communis*
Setae I-6 and II-3 usually single; seta I-7 not longer than I-6 18

18. Seta I-2 with two or more branches; setae VII-9 and VII-6 subequal in length .... *diantaeus*
Seta I-2 usually single, seta VII-9 distinctly longer, generally 1½ times or more longer than VII-6 (fig. 197) 19

19. Metathoracic seta 12 usually 4- to 6-branched (fig. 198); cephalothoracic seta 3 usually double; paddle index (length divided by width) generally 1.34 times or less .... *sticticus*
Metathoracic seta 12 usually single or double; cephalothoracic seta 3 usually single; paddle index generally 1.4 or more 20

20. Seta VII-9 with four to eight branches; seta I-4 usually single (fig. 199) .... *sollicitans*
Seta VII-9 single to triple; seta I-4 usually double or triple 21

21. Seta VIII-9 usually with six or more branches; reticulation heavy on tergum I .... *stimulans*
Seta VII-9 usually with five or less branches; reticulation light or absent on tergum I 22

22. Seta VIII-9 single or double; seta VII-6 usually double or triple; seta VII-8 usually single or double .... *abserratus*
Seta VIII-9 usually with more than two branches; seta VII-6 usually with more than three branches; seta VII-8 usually 3- to 4-branched 23

23. Setae 6 and 7 on segment I subequal (fig. 200); seta IV-4 single .... *intrudens*
Seta I-6 distinctly longer, usually 1.5 to 2 times longer, than seta I-7; seta IV-4 usually double 24

24. Seta II-1 usually with seven or more branches; seta VI-8 usually single or double; seta II-6 usually double .... *canadensis*
Seta II-1 usually with six or fewer branches; setae VI-8 and II-6 usually 3- to 4-branched .... *punctor*

SUBGENUS *AEDES* MEIGEN

Aedes Meigen, 1818. Syst. Beschr. zweifl. Ins. 1:13. Type species: *Aedes cinereus* Meigen, 1818, by monotypy.

For complete synonymy, see Belkin (1962) and Stone *et al.* (1959).

This subgenus is represented in the Holarctic region only by the type species, *Aedes cinereus*.

Aedes (Aedes) cinereus Meigen

Aedes cinereus Meigen, 1818. Syst. Beschr. zweifl. Ins. 1:13. Type loc.: Europe.
Culex nigritulus Zetterstadt, 1850. Dipt. Scand. 9:3459. Type loc.: Sweden.
Aedes fuscus Osten Sacken, 1877. Bull. U.S. Geol. Surv. 3:191. Type loc.: Cambridge, Massachusetts.
Culex pallidohirta Grossbeck, 1905. Can. Entomol. 37:359. Type loc.: Orange Mts., New Jersey.
Aedes cinereus fuscus Dyar, 1924. Insec. Inscit. menstr. 12:179. Type loc.: none given.
Aedes cinereus hemiteleus Dyar, 1924. Insec. Inscit. menstr. 12:179. Type loc.: Lakes Center Camp, Plumas County, California.

For complete synonymy and additional references, see Stone *et al.* (1959:205).

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with narrow, pale, yellowish scales dorsally, large submedian patches of broad, dark brown appressed scales and broad, yellowish-white scales laterally; torus brown, without scales. **THORAX:** Scutum integument brown, uniformly covered with fine, coppery to reddish-brown scales, pale on anterior and lateral margins and in prescutellar space; scutellum with pale golden scales and brown setae; pleura with small separate patches of broad, grayish-white scales, on sternopleuron separate from prealar patch, extending about halfway to propleural patch, not reaching lower margin of mesepimeron; postcoxal area, hypostigial area and metameron bare; lower mesepimeral bristles absent. **ABDOMEN:** Tergites brown-scaled, either unbanded or with narrow basal bands, with basolateral patches usually connected forming longitudinal line; sternites pale-scaled. **LEGS:** Tarsi dark-scaled, unbanded; forecoxae with patches of flat, dark scales. **WINGS:** Scales narrow, dark.

MALE—PALPI: Very short, about one-fourth as long as proboscis. **TERMINALIA:** **Ninth tergite** with broadly rounded, widely separated lobes, each bearing numerous spines. **Tenth sternite** slender, rodlike, heavily sclerotized. **Phallosome** divided into two curved plates, closed at base and apex, open dorsally and ventrally. **Claspette stem** bifurcate, both branches with apical and subapical setae or spines; **filament** absent. **Basistyle** short and stout; basal **lobe** directed inward, bearing many slender setae; apical lobe absent. **Dististyle** inserted subapically, divided unequally, with short branch beacing setae at tip, and long branch bifurcate at tip, each small branch bearing small spines; terminal claw absent.

FOURTH INSTAR LARVA—HEAD: Head hairs 5 and 6 with two or more branches, hair 6 inserted on nearly straight line between hairs 5 and 7. **ABDOMEN:** Abdominal hair 6 single on segments III, IV and V; comb scales 9 to 16, thornlike with strong apical spine and small lateral spinules. **SIPHON:** Siphon index 4.0 to 4.5; pecten teeth extending to beyond middle of siphon, outer one to three teeth detached; siphonal tuft minute. **ANAL SEGMENT:** Saddle incomplete; lateral hair double or triple, shorter than saddle; dorsal pair of gills usually 2 to 2½ times as long as saddle, somewhat longer than ventral pair, pointed.

BIONOMICS

This species overwinters in the egg stage and apparently exhibits the Northern *Aedes* type of life cycle with one generation a year. Barr (1958), however, has found that eggs may not require overwintering to hatch, indicating there may be a second generation. Larvae are often collected in late summer and early fall (Barr, 1958; Mail, 1934; Siverly, 1972), sometimes as late as mid-September. Whether the species is sometimes multivoltine or whether these larvae are actually from late-hatching overwintered eggs is not known (Barr, 1958; Frohne, 1954; Newkirk, 1955; Siverly, 1972). Eggs usually begin hatching about mid-April with some fourth instar larvae present by early May, but the majority of the eggs do not usually hatch until early May, and larvae can usually still be found in woodland pools in the Adirondacks until early June.

Barr (1958) reported that larvae are found in a variety of temporary and semi-permanent pools with no apparent preference. Mullen (1970) and Matheson (1944) found *cinereus* larvae most often in shallow leaf-lined woodland pools in New York (fig. 21); Rees (1943) found them primarily along the margins of mountain streams in Utah and Frohne (1953) found them in brackish water in Alaska. The author has collected *cinereus* larvae from a variety of habitats including shallow, deeply shaded, leaf-lined woodland pools; deep (16–20 inches), lightly shaded, grassy spring-fed pools; semi-permanent, open cattail marshes; clear grassy pools in limestone quarries; acid sphagnum bogs and cool overflow pools near mountain streams; indicating a tolerance for a wide range of acidity. In deep pools, the larvae of *cinereus* are usually found in the shallow parts or adjacent to emergent vegetation; in rocky pools near streams, they are frequently found beneath rocks, vegetation or sticks.

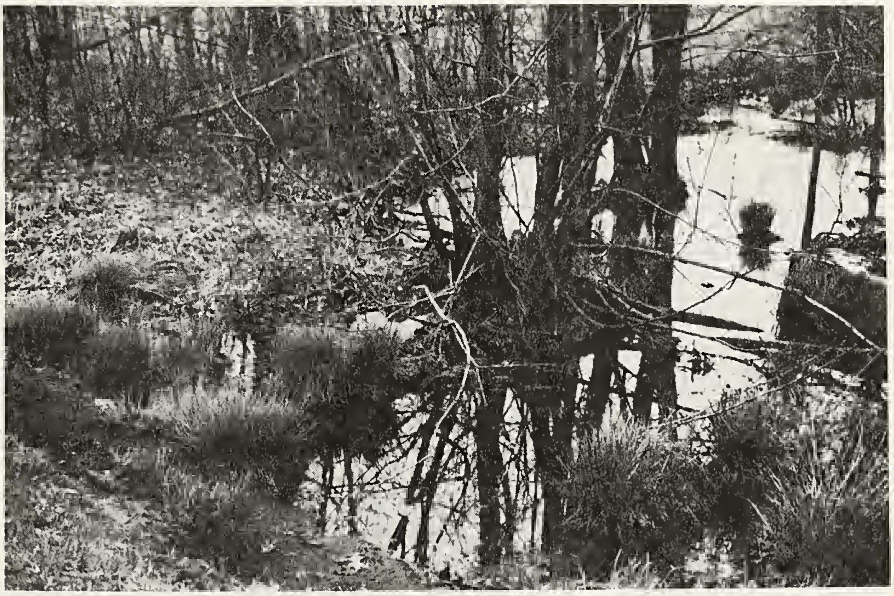

Figure 21. Typical woodland pool habitat for several Northern *Aedes* species of mosquitoes

Mullen (1970) reported finding the larvae of *cinereus* associated with larvae of several species of *Aedes* including *A. canadensis*, *abserratus*, *excrucians*, *fitchii*, *stimulans*, *punctor*, *trichurus* and *vexans* (late summer); *Culiseta morsitans dyari*; *Culex territans*; *Anopheles punctipennis*; *An. walkeri*. In addition to these species, the author has found *cinereus* larvae associated with *A. communis*, *A. diantaeus* and occasionally *Culiseta melanura*.

Female *cinereus* are found almost exclusively in wooded areas, often resting among moist leaves on the forest floor, probably because of high humidity requirements (Barr, 1958) and very little biting occurs even a few yards from wooded places. The greatest feeding activity occurs in the morning and early evening, but feeding also occurs during the day, especially in deeper portions of the woods. The females are aggressive biters, but the bite is usually scarcely noticeable. Feeding most often occurs on the lower extremities, especially around the ankles, and the females rarely fly about the head as do many woodland species.

DISTRIBUTION

Aedes cinereus is widely distributed throughout the United States, Canada, Europe and Asia. It has been reported from most areas of New York State and most likely occurs throughout the State, especially in heavily wooded areas; it is apparently most common in the Adirondacks, Catskills and Finger Lakes regions.

IMPORTANCE

In addition to being a severe local pest in wooded areas, *cinereus* has been shown to be a possible vector of Tularemia (Horsfall, 1955), and is highly susceptible to infection of *Dirofilaria immitis* (Phillips, 1939; Yen, 1938). It has also been found naturally infected with California Encephalitis virus in New York (Whitney *et al.*, 1969).

SUBGENUS *AEDIMORPHUS* THEOBALD

Aedimorphus Theobald, 1903. Monogr. Cul. 3:290. Type species: *Uranotaenia domestica* Theobald, 1901a, by monotypy.

Ecculex Felt, 1904. Bull. N.Y. State Mus. 79:391c. Type species: *Culex sylvestris* Theobald, 1901a, by original designation.

The subgenus *Aedimorphus* is primarily Ethiopian in distribution, represented in the New World only by the *vexans* complex and in New York by a single species, *Aedes vexans* (Meigen).

Aedes (Aedimorphus) vexans (Meigen)

Culex vexans Meigen, 1830. Syst. Beschr. zweifl. Ins. 6:241. Type loc.: Berlin, Germany.

Culex sylvestris Theobald, 1901a. Monogr. Cul. 1:406. Type loc.: Rondeau Provincial Park, Kent Co., and Lake Simcoe, Ontario; Stony Mt., Manitoba, Canada.

Aedes euchrus Howard, Dyar & Knab, 1917. Mosq. North & Centr. Amer. 4:716. Type loc.: Popcum, British Columbia, Canada.

For complete synonymy and additional references, see Carpenter & LaCasse (1955: 263) and Stone *et al.* (1959:198).

IMPORTANT REFERENCE: Gjullin *et al.* (1950)—bionomics.

DIAGNOSIS

FEMALE—HEAD: Proboscis dark-scaled with scattered light-brown scales; palpi dark-scaled, tipped with few white scales; occiput with narrow-pale yellow to golden scales dorsally, broad white to pale-yellowish scales and dark patches laterally; torus yellowish brown to dark brown with few white scales. **THORAX:** Scutum integument brown, uniformly clothed with golden-brown scales, lighter in prescutellar space and on anterior margin; pleura with small, separate patches of grayish-white scales, extending on sternopleuron about halfway to propleural patch, separate from prealar patch, not reaching lower margin of mesepimeron; postcoxal area, hypostigial area and metameron bare; lower mesepimeral bristles absent. **ABDOMEN:** Most tergites dark-scaled with indented basal white bands and basolateral patches, last three segments with apical bands also; sternites pale-scaled, usually with inverted V-shaped black markings. **LEGS:** Most tarsal segments with narrow basal white bands, seldom more than twice as long as wide. **WINGS:** Scales narrow, dark.

MALE—PALPI: About as long as proboscis. **TERMINALIA:** **Lobes of ninth tergite** indistinct. **Tenth sternite** lightly sclerotized. **Phallosome** divided into two small, heavily sclerotized plates bearing strong apical teeth. **Claspette stem** fused to basistyle, stout, pilose, rounded apically with many slender setae; **filament** absent. **Basistyle** with basal and apical lobes absent. **Dististyle** broad, flattened, more than half as long as basistyle; pilose at apex; **claw** subapical, stout.

FOURTH INSTAR LARVA—HEAD: Head hairs 5 and 6 with two to five branches, hair 6 anterior to line between hairs 5 and 7. **ABDOMEN:** Abdominal hair 6 double or triple on segments IV and V, comb scales 8 to 12 in irregular single or double row, each scale thornlike with long central spine and short anterior spinules. **SIPHON:** Siphon index 3.0 to 3.5; pecten extending to middle of siphon or beyond, outer two or three teeth detached; siphonal tuft small, about half as wide as siphon at point of insertion. **ANAL SEGMENT:** Saddle incomplete; lateral hair single or double, shorter than saddle; gills 2 to 2½ times as long as saddle, pointed.

BIONOMICS

Aedes vexans is a temporary pool, floodwater species which lays its eggs in depressions which are subject to freshet flooding. Although eggs are sometimes laid on soil, moss and rotten logs as high as 2 feet above ground (Gjullin *et al.*, 1950), they are usually deposited in the crevices between dead leaves lining shallow depressions (Filsinger, 1941), and most often on clay or loamy soil rather than sandy soil. (Bodman & Gannon, 1950; Gjullin *et al.*, 1950). Gjullin *et al.* (1950) found that eggs are deposited at all levels in the floodplains of rivers between 8- and 25-foot stages with the majority between 10- and 20-foot stages, and are usually placed near the rim of the profile on a depression rather than at the bottom. Dyar (1928) stated that *vexans* prefers open sunlit pools, but Bodman & Gannon (1950) found eggs only in shaded habitats. Gjullin *et al.*, (1950) found eggs of *vexans* (and also *A. sticticus)* to be more abundant on a wooded floodplain rather than in a cleared area. The author has found *vexans* larvae in a wide variety of freshwater habitats, especially in flooded meadows and partially shaded woodland pools which are lined with decaying vegetation (fig. 22).

Overwintering eggs begin hatching after the water temperature of areas innundated by spring flooding reaches 70° F. or more for a week (Gjullin *et al.*, 1950). These authors have also shown that the single most important stimulus affecting hatching is a reduction of dissolved oxygen, a mechanism by which the larvae are assured of adequate organic matter for feeding.

Although evidence has been presented that this species is univoltine (Mail, 1934; Arnold, 1953), several workers (Gjullin *et al.*, 1950; Mitchell, 1907; Jones & Arnold, 1952; Horsfall, 1956; Barr & Azawi, 1958) had no difficulty in hatching eggs in a short time. Barr (1958) stated: "There appears to be no doubt that *vexans* is a multivoltine species."

The eggs of *vexans*, as with other floodwater species, are known to hatch in "installments,"some eggs hatching with the first flooding while others in the same floodplain require two or more floodings before hatching (Wilson & Horsfall, 1970; Breeland & Pickard, 1967; Mallack *et al.*, 1964). According to Gjullin *et al.*, (1950), there are several possible explanations for this: (1) a portion of the eggs are still dormant when flooded in the spring; (2) a rapid rise in the river floodplain may cause part of the egg bed to be flooded deeply, thereby preventing sufficient oxygen reduction for complete hatching; and (3) eggs in the same floodplain may have been deposited at different times by females from different generations. Wilson & Horsfall (1970) have shown that eggs laid on or near the soil surface may become displaced vertically downward, some more than others, and that more than one flooding may be necessary to bring some of the eggs close enough to the surface to hatch. These authors have also shown that the circadian rhythm of light during development of the previous generation affects the hatching of eggs; therefore, eggs deposited at the same time in the same place by different females may hatch at different times.

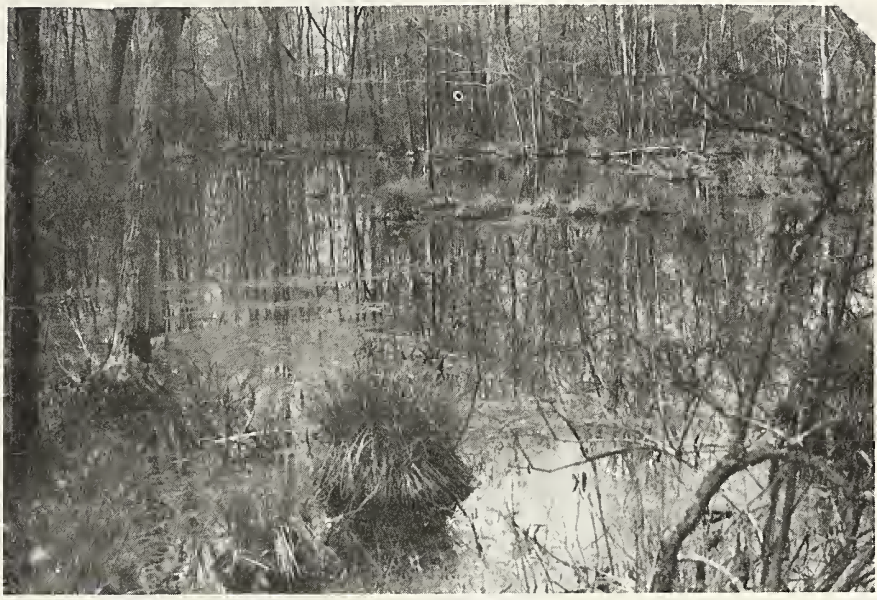

Figure 22. Semi-permanent woodland pool habitat for larvae of *Aedes vexans*, *Culiseta morsitans dyari*, *C. melanura* and several Northern *Aedes* species of mosquitoes

Adults are persistent biters. They are most active in early evening until about midnight, both in the open and in wooded places, but also attack during the day, particularly on cloudy days or in shaded places. Dyar (1928) stated that this is an outdoor pest, not entering houses. However, Steward & McWade (1961) reported that it commonly invades houses and other buildings, and the author has also found this to be one of the most common species attacking man in houses in New York, especially on warm, humid nights in late summer.

The adults are known to fly great distances, commonly as far as 24 km (Stage *et al.*, 1937) and have been reported to migrate more than 22 km in 24 hours (Clarke, 1943). Migrating occurs both as mass movements of both sexes (Horsfall, 1955) and "creeping migration" of individuals (Horsfall, 1955; Rees, 1943) either toward the horizon and a glow of city lights (Horsfall, 1955), following a line of canopy vegetation (Rees, 1943) or omnidirectional (Stage *et al.*, 1937).

DISTRIBUTION

Aedes vexans is a cosmopolitan species, distributed throughout most of Europe, Asia, Africa, the Pacific Islands and North America. It is very common in southern Canada and most of the continental United States, but less so in the extreme South. It is common throughout New York State.

IMPORTANCE

A. vexans is one of the most important pest species due to (1) its abundance; (2) its attraction to lights, especially in urban centers of population; (3) its ability to migrate long distances to urban situations; (4) its particular attraction to humans; and (5) the fact that it readily enters houses to feed.

It is one of the most common species throughout New York, and is especially abundant and annoying from midsummer until the onset of cool weather in the fall. It is not uncommon to have *vexans* biting as late as early November on warm evenings. It is probably the most common and abundant pest of man in heavily populated areas throughout the State.

In addition to being a severe pest, California Encephalitis and Eastern Encephalitis viruses have been isolated from *vexans* from several states, including New York (M. Grayson and J. Woodall, New York State Health Department, pers. comm., 1975; Sudia *et al.*, 1971; Wallis *et al.*, 1960). It has also been incriminated as a possible vector of Dog Heartworm (Ludlam *et al.*, 1970).

SUBGENUS *OCHLEROTATUS* LYNCH ARRIBALZAGA

Ochlerotatus Lynch Arribalzaga, 1891. Rev. Mus. La Plata 1:374; 2:143. Type species: *Ochlerotatus confirmatus* Lynch Arribalzaga [= *Aedes scapularis* (Rondani, 1848)], by subsequent designation (Coquillett, 1910:557).

Taeniorhynchus Lynch Arribalzaga, 1891. Rev. Mus. La Plata 1:374; 2:147. Type species: *Culex taeniorhynchus* Wiedemann, by absolute tautonomy.

Culiseta Felt, 1904. Bull. N.Y. State Mus. 79:391b. Type species: *Culex taeniorhynchus* Wiedmann, by original designation.

Culicada Felt, 1904. Bull. N.Y. State Mus. 79:391b. Type species: *Culex canadensis* Theobald, by original designation.

Protoculex Felt, 1904. Bull. N.Y. State Mus. 79:391d. Type species: *Culex serratus* Theobald, by original designation.

Pseudoculex Dyar, 1905. Proc. Entomol. Soc. Wash. 7:47. Type species: *Culex aurifer* Coquillett, by monotypy.

For complete synonymy see Stone *et al.* (1959:137).

Ochlerotatus is the best represented subgenus of *Aedes* in New York, with 26 species. Of these, 15 species are common either throughout the State or at least in some sections; three species are uncommon, but sometimes occur in moderate abundance and eight species are rare, some having been reported only once.

Males of the subgenus *Ochlerotatus* are characterized as follows: **PALPI:** Usually longer than proboscis, sometimes of equal length or a little shorter. **TERMINALIA: Lobes of ninth tergite** variable in shape, usually sclerotized and with several strong setae or spines (absent in *atropalpus*). **Tenth sternite** variously sclerotized distally. **Phallosome** simple, smooth, not divided into lateral plates, usually open ventrally, closed dorsally. **Claspette** usually well developed with columnar stem and flattened filament. **Basistyle** elongate, subcylindrical or subconical; **basal lobe** variable in shape, sometimes with setae and/or spines; **apical** lobe present or absent, variable in shape and size if present. **Dististyle** elongate, sometimes expanded medially; **claw** slender, less than one-third as long as dististyle. Additional characters to separate species are included in the synopsis of each species.

Aedes (Ochlerotatus) abserratus (Felt & Young)

Culex abserratus Felt & Young, 1904. Science 20:312. Type loc.: Elizabethtown, New York.

Aedes centrotus Howard, Dyar & Knab, 1917. Mosq. North & Centr. Amer. 4:747. Type loc.: Ontario, Canada.

Aedes dysanor Dyar, 1921. Insec. Inscit. menstr. 9:70. Type loc.: Plattsburgh, New York.

Aedes implacabilis, authors, not Walker (Vockeroth, 1954b: 114, syn.).

IMPORTANT REFERENCE: Vockeroth (1954b: 115)—resurrected from synonymy with *implacabilis*.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with narrow white to yellow scales dorsally, broad, appressed white scales laterally; torus brown, occasionally with patch of white to grayish-white scales on inner surface. **THORAX:** Scutum usually uniformly clothed with small, fine coppery scales, sometimes more dense medially, thus appearing as dark stripes; occasionally with one or two stripes of dark-brown to black scales medially and yellowish laterally; postpronotum usually with patch of coppery scales; pleura with irregular patches of grayish-white scales extending on sternopleuron to propleuron and on mesepimeron to lower margin; postcoxal area and metameron with pale scales; hypostigial area without scales; lower mesepimeral bristles 1 to 3. **ABDOMEN:** Tergites dark-scaled with basal white bands; some sternites pale-scaled with a few dark scales apically. **LEGS:** Tarsi dark, unbanded; first segment pale-scaled posteriorly. **WINGS:** Scales narrow, dark; costa without basal patch of white scales.

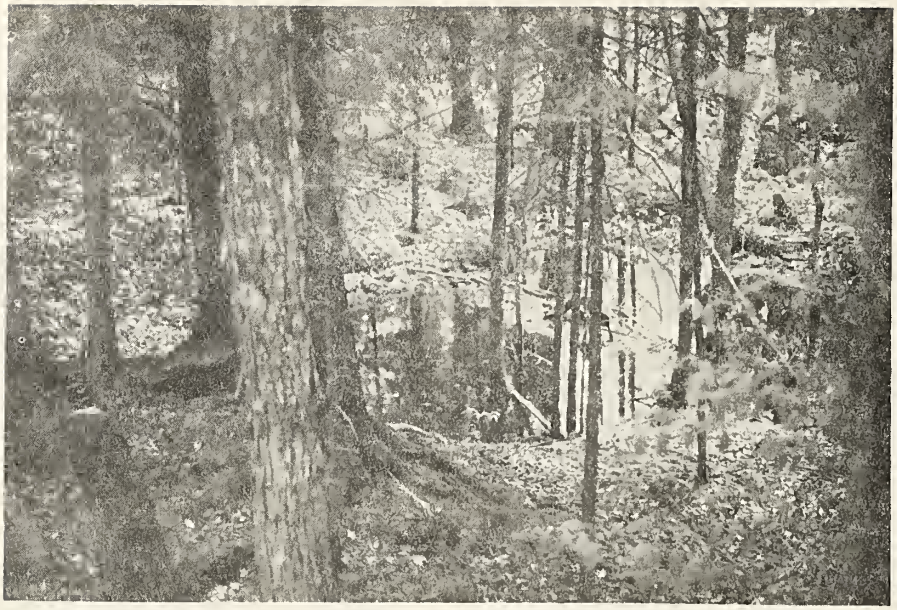

Figure 23. Cool water woodland pool habitat for larvae of *Aedes punctor*, *A. canadensis*, *Culiseta melanura*, *C. morsitans dyari* and other mosquito species

MALE TERMINALIA—**Lobes of ninth tergite** sclerotized, each with several strong spines. **Tenth sternite** heavily sclerotized distally. **Phallosome** cylindrical, rounded and notched apically. **Claspette** stem short, slender, pilose on basal half; **filament** nearly as long as stem, broadly expanded near middle, recurved at tip. **Basistyle** about three times as long as width at middle; **basal lobe** moderately large, triangular with many short setae, with basal row of long setae and dorsal spine; apical lobe broadly rounded, with short curved setae.

FOURTH INSTAR LARVA—**HEAD:** Antenna about half as long as head, spiculate; head hairs 5 and 6 stout, barbed, usually single (occasionally double); hair 7 usually 2- to 4-branched, barbed, **THORAX:** Prothoracic hairs 1, 2 and 3 long, subequal, usually all single (1 and/or 3 occasionally double). **ABDOMEN:** Comb with four to eight scales in irregular row, each scale thornlike with basal spinules and nearly as long as outer pecten tooth. **SIPHON:** Siphon index 3.5 to 4.0; pecten with outer one to three teeth separated; dorsal preapical spine about half as long as outer pecten tooth. **ANAL SEGMENT:** Saddle complete; lateral hair single, slightly longer than saddle; dorsal brush consisting of two pairs of long single hairs; gills usually about 1½ to 2 times as long as saddle, tapered.

BIONOMICS

The eggs of this univoltine species are laid singly during the summer on damp earth, leaves or vegetation lining depressions in heavily wooded areas throughout the State (fig. 23).

The larvae are among the first to appear as soon as the ice has melted from woodland pools or even before all the ice has melted (Siverly, 1972), beginning in early April in southern sections of the State and late April through mid-May in northern and mountainous sections. The larvae are often found associated with larvae of *Aedes punctor, A. canadensis, A. excrucians, A. stimulans, A. trichurus* and *A. intrudens.* Larvae have been collected from tire ruts in semi-shaded logging roads in the Adirondacks, but are commonly found in dense woods and sphagnum bogs. They are easily overlooked because of their affinity for dark, cool corners of their breeding pools and often stay under leaves or other bottom debris for long periods.

In the open, adult females are usually active only at dusk, but within the forest, especially in dense humid areas, they are active throughout the day and are persistent biters. Although the females usually are not found very far from their breeding areas, they sometimes become a problem locally. Specific hosts, other than man, are not known except that several species of birds and mammals are readily fed upon (Hayes, 1961a; Means, 1968).

DISTRIBUTION

A. *abserratus* is distributed throughout most of the northeastern United States from Minnesota to the Atlantic coast and southeastern Canada from Ontario to Nova Scotia. In New York, it is found locally in forested regions throughout the State, with Long Island being near its southern limit.

IMPORTANCE

Although it is not as common or widespread as many other northern *Aedes* species, this species can be quite abundant locally, especially near forested areas. Other than being a pest and contributing to the discomfort of fishermen and vacationers, A. *abserratus* is of no known economical or medical importance.

Aedes (Ochlerotatus) atlanticus Dyar & Knab

Aedes atlanticus Dyar & Knab, 1906. Jour. N.Y. Entomol. Soc. 14:198. Type loc.: New Jersey and Sanford, Florida.

Culex serratus, of Felt, not Theobald, 1904. Bull. N.Y. State Mus. 79:334. *New Synonymy*.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with broad median stripe of narrow, lanceolate white scales and large submedian patches of broad, dark scales dorsally; broad, appressed, dingy white scales laterally; torus yellow, inner surface light brown with small brown setae; **THORAX:** Scutum and scutellum with median stripe of silvery-white to pale-yellow scales continuing from occiput, densely clothed laterally with fine dark-bronze to brown scales; pleura with small, well-defined patches of broad, grayish-white to silvery-white scales extending on sternopleuron about halfway to propleuron and on mesepimeron halfway to lower angle; hypostigial area, postcoxal area and metameron without scales; lower mesepimeral bristles absent. **ABDOMEN:** Tergites dark-scaled with triangular patches of silvery-white scales; sternites white-scaled, usually with scattered dark scales. **LEGS:** Tarsi dark-scaled, unbanded. **WINGS:** Scales narrow, dark.

MALE TERMINALIA—Lobes of ninth tergite nearly as long as broad, each with four to seven short, stout spines. **Tenth sternite** heavily sclerotized apically. **Phallosome** stout, subconical, broadly rounded apically. **Claspette** stem long, stout, constricted near base and apex, broad medially, pilose; **filament** very short (less than half as long as stem), striated. **Basistyle** about three times as long as wide; **basal lobe** large, much narrowed and partially detached basally, greatly expanded distally, bearing numerous fine setae apically and a long, stout recurved dorsal spine near middle; **apical lobe** long, triangular, pointed apically. **Dististyle** about two-thirds as long as basistyle, pilose.

FOURTH INSTAR LARVA—HEAD: Antenna less than half as long as head, head hairs 5 and 6 single, sparsely barbed. **THORAX:** Prothoracic hair 1 long, single; 2 short, single; 3 short, double or triple. **ABDOMEN:** Comb with 4 to 6 large scales in curved row, each scale thornlike with minute basal spinules and large central spine. **SIPHON:** Siphon index about 2.0; pecten teeth evenly spaced; siphonal tuft multiple, barbed, about as long as width of siphon at point of insertion; dorsal preapical spine much shorter than outer pecten tooth. **ANAL SEGMENT:** Saddle complete; lateral hair single or double, shorter than saddle; gills variable, dorsal pair usually one to four times as long as saddle, longer than ventral pair, pointed.

BIONOMICS

This species overwinters as eggs in shallow depressions subject to spring or summer flooding. There are apparently several generations a year, at least in the Southern States (Horsfall, 1955). Larvae are found in temporary pools filled by controlled flooding operations and by summer rains beginning in late spring and continuing throughout the summer and fall. They are usually found in clear shallow pools which are partially to densely shaded and contain grass or other emergent vegetation (Horsfall, 1955; Siverly, 1972; Breeland *et al.*, 1961; Carpenter & LaCasse, 1955). Among the mosquito species commonly associated with *atlanticus* are *A. vexans*, *A. trivittatus*, *Psorophora confinnis*, *P. ferox*, *Culex restuans* and several species of *Aedes* and *Psorophora* not occurring in New York.

The females, sometimes referred to as "silver-striped mosquitoes" (Headlee, 1945) because of the broad, silvery, longitudinal stripe on the mesonotum, are persistent, vicious biters. They are active day and night, with peak feeding periods at dusk and dawn. Although man is undoubtedly a common host of A. *atlanticus*, little is known of host preferences except that it will also feed on turtles (Crans, 1968; Crans & Rockel, 1968).

DISTRIBUTION

Aedes atlanticus is distributed throughout most of the southeastern United States west to Texas and Kansas, north to New York. It is a common species in Delaware and other southeastern states (R. W. Lake, University of Delaware, pers. comm. 1974). It has been reported from New York only twice, once from Nassau County (Richards, 1938) and once from Richmond County (Felt, 1904).

IMPORTANCE

Several strains of California Encephalitis virus have been isolated from the *Aedes atlanticus/tormentor* group in Florida and Texas (Sudia *et al.*, 1971). However, since New York is essentially out of the range for this species, it is of no economic importance to the State.

Aedes (Ochlerotatus) atropalpus (Coquillett)

Culex atropalpus Coquillett, 1902. Can. Entomol. 34:292. Type loc.: Plummers Island, Maryland.

Aedes spaticus Dyar & Knab, 1908. Proc. U.S. Nat. Mus. 35: 53. Type loc.: Mexico.

Aedes (Finlaya) atropalpus (Coquillett), of Stone *et al.* (1959) and other authors.

For complete synonymy and additional references, see Carpenter (1968:83), Carpenter & LaCasse (1955: 254), Stone *et al.* (1959:159) and Zavortink (1972: 102).

IMPORTANT REFERENCES: Shaw & Maisey (1961)—bionomics; Zavortink (1972)—revision of subgenus *Finlaya*.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with narrow, yellowish-white scales dorsally, broad, white scales with dark patches laterally; torus light brown to black with white scales on inner surface. **THORAX:** Scutum with broad, median stripe or pair of stripes of dark-brown scales, much widened posteriorly, yellowish to light-golden scales anteriorly and laterally and usually few pale-golden scales in prescutellar space; pleura with small, distinct, separate patches of broad, flat, silvery-white scales, extending on sternopleuron about halfway to propleural patch and on mesepimeron about halfway to lower margin; postcoxal area, hypostigial area and metameron bare; lower mesepimeral bristles absent. **ABDOMEN:** Tergites black-scaled with basal white bands; sternites pale-scaled with dark scales apically. **LEGS:** Most tarsal segments with both basal and apical bands of white scales. **WINGS:** Scales narrow, dark with patch of white scales at base of costa.

MALE TERMINALIA—Lobes of ninth tergite inconspicuous, without spines. **Tenth sternite** heavily sclerotized on distal half. **Phallosome** slightly expanded distally, rounded at apex. **Claspette stem** slender, pilose, with prominent subapical tubercle bearing seta; **filament** slender, curved, shorter than stem. **Basistyle** 3 to 3½ times as long as wide; **basal lobe** a slightly raised dark area bearing many long setae; **apical lobe** absent. **Dististyle** not expanded medially, glabrous, with two or three small subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna almost half as long as head; head hairs 5 and 6 single. **THORAX:** Prothoracic hair 1 long, single or double; 2 short, single; 3 short, single or triple. **ABDOMEN:** Comb with about 20 to 60 scales in triangular patch, each scale short, blunt, fringed apically with subequal spinules. **SIPHON:** Siphon index about 1.5 to 2.5; pecten extending almost to apex of siphon, outer two to four teeth detached, frequently smaller than those near middle of siphon; siphonal tuft inserted within pecten at about middle of siphon, with four to nine branches, barbed, about three-fourths as long as width of siphon at point of insertion. **ANAL SEGMENT:** Saddle incomplete, covering dorsal half of segment, with strong spinules posteriorly; lateral hair single or double, much shorter than saddle, inserted in membranous area below saddle; gills usually 2 to 4 times as long as the saddle, pointed.

BIONOMICS

Aedes atropalpus, commonly referred to as the "rockpool" mosquito, is unique in that the immature stages are most often found in depressions or holes near waterfalls and rapids of streams, which become filled with water after a rain storm or when the stream is at a high level (Hedeen, 1953; Shaw & Maisey, 1961; Carpenter & LaCasse, 1955) (fig. 24). Larvae have been collected from treeholes, artificial containers, an abandoned septic tank (Shields, 1938) and from discarded tires (Strom *et al.*, 1960), but these habitats are thought to be unusual. The species overwinters as eggs which are deposited on the edge of the rockpool or other container just above the water level. These eggs hatch in the spring when the water temperature reaches 40° to 50° F. or more, at about the time pussy willows and soft maples come into bloom in April or May (Shaw & Maisey, 1961). Eggs of subsequent generations from April through November are deposited on the water surface.

Development from newly hatched larva through adult takes approximately 8–9 days at the optimum water temperature of 90° F., 30 days at 60°. Larvae hatching late in the season usually die without completing development (Shaw & Maisey, 1961; Hedeen, 1953). Larvae are negatively phototropic and spend much of the time at the bottom of the pool under rocks or debris. Fourth instar larvae are able to remain submerged for up to 20 hours (Hedeen, 1953), which often makes them difficult to collect, especially from small rockpools formed in rough, jagged rock. It is sometimes most practical to siphon the water from such holes with a piece of flexible tubing or to remove the water with a large bulb syringe.

Larvae of *Culex territans*, *C. restuans* and *Anopheles punctipennis* are occasionally, but not commonly, found associated with *atropalpus* in rockpools. James (1964) reported these same species as associates of *atropalpus* and Hedeen (1953) included *Orthopodomyia alba, O. signifera, Aedes triseriatus, Psorophora confinnis* and some species which do not occur in New York, as occasional associates.

Female *Aedes atropalpus* attack man readily any time during the day or night, even in bright sunlight, and are sometimes very troublesome in the vicinity of their breeding areas, but they seldom travel far from these areas. The author has often had several dozen *atropalpus* biting or annoying while collecting larvae from rockpools along an open stream, but had none follow him into the woods bordering the stream. Other than humans and laboratory feeding on white rats, guinea pigs and chickens (Trembley, 1947), the author has found no published host records for this species, but has collected *atropalpus* feeding on a dog. Possibly deer or other large mammals which go to the streams for water serve as the normal hosts. Trembley (1947) found that this species is autogenous.

DISTRIBUTION

Aedes atropalpus occurs in Mexico, Central America, eastern Canada and eastern United States west to the Rocky Mountains (Shaw & Maisey, 1961; Stone *et al.*, 1959). It is distributed throughout New York State wherever there are cool, fast-flowing, rocky streams, especially near waterfalls. It is most commonly collected in the Adirondack and Catskill regions, but it has also been reported from Westchester County, New York City, and Tompkins County. The author has collected larvae along the Genesee River in Livingston and Wyoming Counties and from Allegany and Cattaraugus Counties.

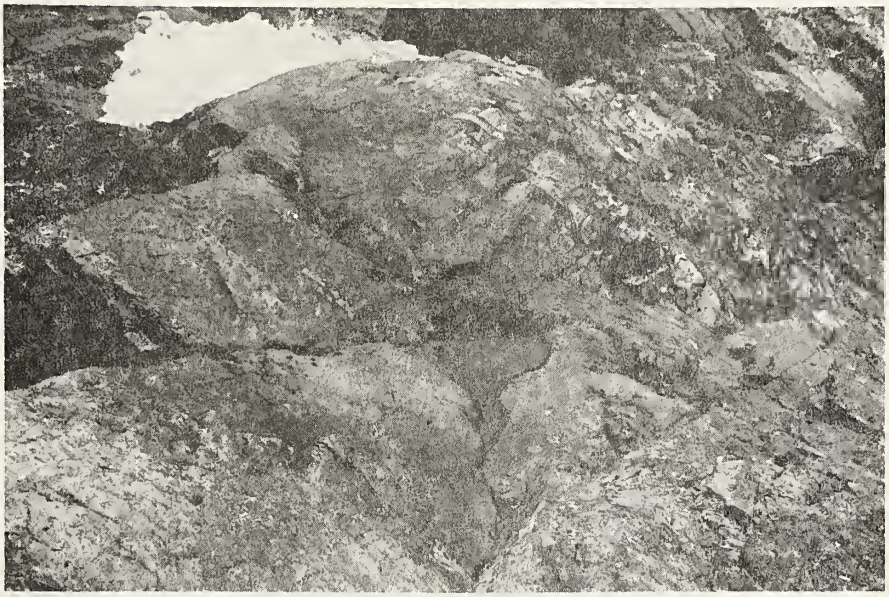

Figure 24. Habitat at edge of river for the rockpool mosquito, *Aedes atropalpus*

IMPORTANCE

Aedes atropalpus has been shown to be an efficient vector of Eastern and Western Encephalitis viruses (Chamberlain *et al.*, 1954; Davis, 1940; Jakmauh, 1940). It has also been implicated as a vector of bird malaria *(Plasmodium gallinaceum)* (Trembley, 1946). However, because of its specialized habitat, it is probably not an important vector of these diseases (Hedeen, 1953). Since it appears not to fly far from its breeding habitat and usually does not occur in great abundance, it probably is of minor importance as a pest species.

Aedes (Ochlerotatus) aurifer (Coquillett)

Culex aurifer Coquillett, 1903. Can. Entomol. 35:255.
Type loc.: Center Harbor, New Hampshire.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with large median patch of yellow to yellowish-white scales and submedian patches of black scales dorsally, broad appressed yellowish-white scales laterally; torus dark brown. **THORAX:** Scutum with broad median stripe of black or purplish-black scales widened posteriorly, pale-golden scales laterally; postpronotum usually with patch of dark scales; pleura with patches of grayish-white scales extending on sternopleuron about halfway to propleuron, not reaching lower margin of mesepimeron; hypostigial area, postcoxal area and metameron without scales; lower mesepimeral bristles absent. **ABDOMEN:** Tergites dark-scaled with small triangular basolateral patches of pale scales, sometimes with much narrowed, pale, basal bands; sternites pale-scaled only. **LEGS:** Tarsi very dark-scaled with bronze-blue reflection, unbanded; forecoxae with small patches of dark scales. **WINGS:** Scales narrow, dark.

MALE TERMINALIA—Lobes of ninth tergite nearly as long as broad, each bearing several short, stout spines. **Tenth sternite** sclerotized apically. **Phallosome** cylindrical or broadly conical, narrowed and rounded apically. **Claspette** stem slender, pilose, bearing a short subapical seta; **filament** large, as long as stem or slightly longer, with large, sharp, retrorse projection near middle, tapered and curved apically. **Basistyle** 2 to 2½ times as long as wide, with dense tuft of long setae at apex; **basal lobe** a broad, slightly raised plate bearing many setae and a long, stout, backward projecting apical spine; **apical lobe** a slight expansion, bearing short curved and straight setae. **Dististyle** pilose, with two or three short subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna approximately as long as head, strongly curved, swollen and white at base, very dark at apex with three long subequal and one short terminal setae; head hairs 5 and 6 long, single to triple, hair 7 multiple, all inserted in a straight line. **THORAX:** Prothoracic hair 1 long, single; 2 and 3 short, single or double. **ABDOMEN:** Comb with 10 to 30 scales (usually 20) in patch, each scale thornlike with long median spine and shorter lateral spinules. **SIPHON:** Siphon index 3.5 to 4.0; pecten with outer two to four teeth usually longer than or detached from other teeth; siphonal tuft as long as width of siphon at point of insertion; dorsal preapical spine much shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete, spiculate at apex; lateral hair single, almost as long as saddle; gills approximately as long as saddle, pointed.

BIONOMICS

The eggs of this univoltine Northern *Aedes* species (Pratt, 1959) hatch early in the spring (mid-March to mid-April in Suffolk County, early April to May in St. Lawrence and Essex Counties) soon after, or even before, all ice has left the woodland pools. The author has collected first instar *aurifer* larvae associated with second and third instar *A. canadensis* and fourth instar *A. abserratus* on April 15 and has collected fourth instar *aurifer* associated with fourth instar *A. abserratus*, *A. canadensis* and *A. cinereus* on May 4 in Suffolk County. Other species with which the larvae of *aurifer* are sometimes associated include *A. excrucians*, *A. grossbecki* and *A. vexans* (Siverly, 1972). Headlee (1945) reported that although the larvae are among the earliest to appear and develop rapidly at first, the pupae require several days to mature.

Carpenter & LaCasse (1945), Siverly (1972) and others have reported that the larvae of *A. aurifer* commonly occur in acid cranberry and peat bogs and that they are usually found several feet from shore. The author has collected a few larvae (never in great numbers) from shaded sphagnum bogs and from open cattail (*Typha* spp.) bogs, usually several feet from shore in water 12 or more inches deep. Matheson (1944) reported, and the author has observed, that the larvae were peculiar in that they lie almost parallel to and very near the water surface.

Females usually remain near their breeding place during the day, but may fly some distance at night (Headlee, 1945). They have been reported to be vicious biters, even during the day (Carpenter & LaCasse, 1955; Headlee, 1945; Siverly, 1972; Dyar, 1928), a fact which the author has observed on the few occasions when he has encountered the species. They are also persistent and difficult to avoid since they tend to land on the head, especially about the ears.

DISTRIBUTION

Aedes aurifer is distributed throughout much of the northeastern and north central United States and southern Canada (Carpenter & LaCasse, 1955; Siverly, 1972). In New York, it has been collected from several widely scattered localities in the counties of Cayuga, Dutchess, Essex, Niagara, Oneida, Onondaga, Orange, Queens, St. Lawrence, Schuyler, Suffolk, Tompkins and Wayne and probably occurs locally throughout the State.

IMPORTANCE

This species is uncommon and not usually found in large numbers in New York, although Matheson (1944) reported collecting it in great abundance near Cayuga Lake (Schuyler County). Aside from being a local nuisance, *A. aurifer* is of no known medical or economic importance in New York.

Aedes (Ochlerotatus) canadensis canadensis (Theobald)

Culex canadensis Theobald, 1901. Monogr. Cul. 2:3. Type loc.: Ontario, Canada.

Culex nivitarsis Coquillett, 1904. Jour. Entomol. Soc. Wash. 6:168. Type loc.: Patterson, New Jersey.

DIAGNOSIS

FEMALE—HEAD: Proboscis dark-scaled; palpi dark-scaled with few white scales at tip and base of segment 4; occiput with median patch of narrow white to yellowish-white scales and submedian areas of narrow, golden-brown to reddish-brown scales dorsally, broad, appressed, whitish scales and often small, dark patches laterally; torus dark brown, usually with few dark scales on inner surface. **THORAX:** Scutum with fine narrow golden-brown to reddish-brown or dark-brown scales, often with posterior half-stripes of pale-golden scales and usually with pale-golden scales on anterior and lateral margins and in prescutellar space; pleura with small, separated, well-defined patches of flat, grayish-white scales extending on sternopleuron about halfway to propleuron, not reaching lower margin of mesepimeron; hypostigial area, postcoxal area and metameron without scales; lower mesepimeral bristles absent. **ABDOMEN:** Tergites dark-scaled, usually with narrow basal bands of pale scales (occasionally lacking) and with basolateral triangular patches of pale scales; apical margin of segment 7 and often segment 6 pale-scaled; sternites usually with pale scales only. **LEGS:** Tibiae and most tarsal segments with basal and apical bands of pwle scales. **WINGS:** Scales narrow, dark.

MALE TERMINALIA—Lobes of ninth tergite about as long as broad, each bearing four to eight short, stout setae. **Tenth sternite** heavily sclerotized apically. **Phallosome** nearly twice as long as broad, rounded apically. **Claspette stem** slender, pilose, with two small subapical setae; **filament** rodlike, evenly tapered, about two-thirds as long as stem. **Basistyle** 2½ to 3 times as long as width at middle; **basal lobe** large, triangular, densely clothed with short setae; **apical lobe** broadly rounded, with numerous short, flattened setae. **Dististyle** about two-thirds as long as basistyle, pilose, expanded medially; **claw** slender, about one-fifth as long as dististyle.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head, spiculate; head hairs 5 and 6 usually 3- to 10-branched. **THORAX:** Mesothoracic hair 1 pale, shorter than number 3, much shorter than antenna or head hairs 5 and 6. **ABDOMEN:** Comb scales 25 to 40 in patch, each scale fringed with subequal spinules. **SIPHON:** Siphon index 3.0 to 4.0; pecten index less than 0.5; siphonal tuft at least three-fourths as long as pecten. **ANAL SEGMENT:** Saddle incomplete; lateral hair single, almost as long as saddle; gills as long as or longer than saddle; dorsal preapical spine more than two-thirds as long as outer pecten tooth.

BIONOMICS

Although *A. canadensis* is a common species throughout most of the United States and Canada, its life cycle is not completely understood. It overwinters in the egg stage (Barr, 1958; Newkirk, 1955). Since larvae have been collected in Nassau County as late as December 17, and in Schenectady County as early as February 15 (New York State Museum collection), larval overwintering might occasionally occur as stated by Felt (1904). *Aedes canadensis* is generally considered to have the Northern *Aedes* type of life cycle and is one of the earliest species to hatch in the spring, the larvae appearing as soon as there are openings in the ice-covered woodland pools. Frequently these early hatching larvae are seen beneath the ice when pools refreeze with drops in the temperature. Horsfall reported (1955), and the author has collected, first instar *canadensis* larvae completely frozen in blocks of ice. Development was normal after the ice had melted.

Larvae usually appear in abundance in early April through mid-May in the southern part of the State and at lower elevations, and early May through early June at higher elevations, especially in late-melting sphagnum bogs in the Adirondacks. Larvae are frequently collected, though usually less abundantly, during the summer and late into the fall, especially following heavy rains (Carpenter, *et al.*, 1946; Matheson, 1944; Newkirk, 1955). This might be due to delayed hatching of eggs (Felt, 1904; Matheson, 1944; Steward & McWade, 1961) or, since eggs of *canadensis* do not require exposure to cold in order to hatch (Newkirk, 1955), the species may sometimes be multivoltine (Rudolphs & Lackey, 1929; Siverly, 1972).

Larvae of *canadensis* are normally found in clean, cool water in semishaded woodland pools, but also occur in a variety of habitats ranging from open grassy roadside ditches to dark cellars. Other species with which *canadensis* is commonly associated in New York include *A. cinereus*, *A. abserratus*, *A. punctor*, *A. stimulans*, *A. excrucians*, *A. fitchii*, *A. intrudens*, *A. vexans*, *A. communis*, *Culiseta morsitans* and *C. melanura*.

Female *canadensis* usually remain in the woods near their larval habitat where they attack readily during the day and especially in the evening and early morning. Although *canadensis* females do not normally enter houses (Matheson, 1944; Headlee, 1945), the author has on several occasions collected specimens biting man in dwellings, sometimes in moderate abundance, always within 50-70 yards of their usual wooded habitat. This species has been variously described as a "fierce biter" in Illinois (Ross, 1947) and a species which "seldom feeds on man, even when it is very abundant" in the Tennessee Valley (Snow *et al.*, 1961). In New York, as reported by Headlee (1945) in New Jersey, *canadensis* appears to be a species which bites readily, but is easily "scared off."

Females of *canadensis* are attracted to and feed readily on a variety of animals, especially mammals, amphibians and reptiles, with birds being somewhat less attractive (Hayes, 1961a; Means, 1968; Wright & DeFoliart, 1970). In addition to man, this species has been collected feeding on the following animal species: **BIRDS:** Blue Jay, Bobwhite, Catbird, Chicken, Common Grackle, Common Raven, Domestic Pigeon, English Sparrow, Rufous-sided Towhee, Red-winged Blackbird, Ring-necked Pheasant, Ruffed Grouse, Starling, White Pekin Duck, White-throated Sparrow; **MAMMALS:** Beaver, Domestic Rabbit, Eastern Chipmunk, Eastern Cottontail, Eastern Gray Squirrel, Fox Squirrel, Ground Squirrel, Little Brown Bat, Meadow Vole, New England Cottontail, Norway Rat, Opossum, Raccoon, Red-backed Vole, Red Fox, White-footed Mouse, Whitetail Deer, Woodchuck; **REPTILES:** Blacksnake, Blanding's Turtle, Eastern Box Turtle, Eastern Garter Snake, Eastern Painted Turtle, Eastern Spotted Turtle, Northern Water Snake, Snapping Turtle; **AMPHIBIANS:** Bullfrog, Green Frog, Leopard Frog (Means, 1968; Wright & DeFoliart, 1970; Hayes, 1961a; Crans, 1964; Nolan *et al.*, 1965; DeFoliart, 1967; Crans & Rockel, 1968; Downe, 1960; Wallis, 1960).

DISTRIBUTION

A. canadensis is widely distributed throughout forested areas of the United States and Canada (for list of states and provinces, see Carpenter & LaCasse, 1955). It is one of the most common species in New York State, occurring throughout the State.

IMPORTANCE

Several strains of California Encephalitis have been isolated from *canadensis* in New York and elsewhere in the country (M. Grayson and J. Woodall, New York State Health Department, pers. comm., 1975; Sudia *et al.*, 1971; McLean, 1970). It has also been incriminated as a potential vector of canine filariasis *(Dirofilaria immitis)* with a high percentage of infection in laboratory experiments (Ludlam *et al.*, 1970; Yen, 1938).

There are conflicting reports of its importance as a pest (Carpenter & LaCasse, 1955; Siverly, 1972). The author has found that in many parts of New York, primarily in wooded areas and especially in late spring and early summer, *canadensis* is one of the most important pest species.

Aedes (Ochlerotatus) cantator (Coquillett)

Culex cantator Coquillett, 1903. Can. Entomol. 35:255. Type loc.: New Jersey.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with narrow, yellowish-white to pale, golden-brown scales dorsally, broad dingy-yellow scales laterally, usually with scattered dark scales or patches laterally; torus brown with few pale scales on inner surface. **THORAX:** Scutum uniformly clothed with narrow golden-brown, reddish-brown or dark-brown scales, usually pale on anterior and lateral margins and in prescutellar space; pleura with patches of broad, appressed, grayish-white to yellowish scales narrowly extending on sternopleuron to propleuron, not reaching lower margin of mesepimeron; hypostigial area and postcoxal area without scales; metameron with pale scales; lower mesepimeral bristles usually one to three, occasionally none. **ABDOMEN:** Tergites dark-scaled with basal bands of white to yellowish scales, widened laterally, last two segments usually entirely pale-scaled; sternites with yellowish-white scales. **LEGS:** Most tarsal segments dark-scaled with basal bands of white to yellowish-white scales. **WINGS:** Scales narrow, brown.

MALE TERMINALIA—Lobes of ninth tergite about as long as broad, each with several short, stout spines. **Tenth sternite** heavily sclerotized apically. **Phallosome** cylindrical, longer than broad, rounded and notched apically. **Claspette stem** short, slender, pilose; **filament** longer than stem, with a broad, flat, rounded expansion medially, tapered to recurved tip. **Basistyle** 3½ times longer than wide or longer, **basal lobe** short, rounded, with many short fine setae, two or three long fine setae apically and long strong dorsal spine; **apical lobe** rounded, bare or nearly so. **Dististyle** nearly two-thirds as long as basistyle, pilose on inner surface, with three or four short subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head, spiculate; head hairs 5 and 6 usually 3- to 10-branched, number 7 multiple, usually 8- to 12-branched. **THORAX:** Mesothoracic hair 1 well developed, longer than number 3 or head hairs 5 and 6, subequal to antenna. **ABDOMEN:** Comb scales thorn-like, median spine longer and stouter than subapical spines, in patch of 20 to 40. **SIPHON:** Siphon index 2.5 to 3.0; pecten index less than 0.5, teeth evenly spaced; siphonal tuft with hairs at least three-fourths as long as pecten, inserted at or before middle of siphon. **ANAL SEGMENT:** Saddle incomplete, covering dorsal two-thirds of segment; lateral hair single, about as long as saddle; gills usually shorter than saddle and budlike (occasionally longer in fresh water); dorsal preapical spine more than two-thirds as long as outer pecten tooth.

BIONOMICS

Aedes cantator, the "brown salt marsh mosquito," is a multivoltine species which breeds in temporary pools of either brackish or fresh water, especially in pools containing little or no salt bordering coastal salt marsh areas. Larvae have also been collected from brackish pools further inland in New York and, in recent years, have been found in brackish pools along the New York State Thruway and other highways, probably a result of the large amounts of salt used to clear the roadways of ice in the winter. Richards (1938) found *cantator* larvae frequently in association with the larvae of *A. sollicitans*, the "white banded marsh mosquito," However, *cantator* larvae were tolerant of only slightly saline water (6-8 percent), therefore usually occurred on the upland portion of the marsh while *sollicitans* were found in the lower, more saline regions. This distribution of the larvae in the marsh explains why larvae of *cantator* are frequently as abundant or even more abundant than *sollicitans*, but the adults often form a small percentage of the mosquito population on or from the salt marsh. The upper regions of the marsh drain more rapidly, especially if the marshes are ditched, and the pools are not replenished by daily high tides for 10-14 days following monthly high tides. This allows pools on the upper regions to dry up, thereby preventing a large portion of *cantator* larvae from completing development while *sollicitans* larvae in the more saline pools lower on the marsh, which are replenished with daily high tides, complete their development.

Smith (1904a) has described the habits of the early stages in detail. Eggs are deposited singly on mud, as are the eggs of *A. sollicitans*. Smith states that *sollicitans* females deposit up to 200 eggs and that *cantator* deposits "more." The eggs must dry, or at least not be water-covered, for at least 24 hours, and may remain viable on dry soil for 3 months or more. All eggs may hatch within minutes after being inundated, although partial hatching may occur with 50 percent or more remaining unhatched until a second or third flooding. Some eggs remain through the winter to hatch the following spring. In New Jersey, overwintering eggs begin hatching in March, the adults emerging from early April until early May. A second generation of larvae appear in early June, and larvae of successive broods are found throughout the summer whenever pools are reflooded. On Long Island, second instar larvae have been collected by March 15th, fourth instar larvae in mid-April and throughout the summer and adults from mid-April until later September.

Larvae are most often associated with *Aedes sollicitans*, *Aedes vexans*, *Culex salinarius* and *Culex pipiens* on or adjacent to salt marsh (Richards, 1938). The author has also found these species in western New York near Syracuse and in pools adjacent to large highways leading to the western part of the State. Larvae of *cantator* have occasionally been found associated with *Aedes cinereus*, *A. canadensis* and *Culex territans* in freshwater roadside ditches (fig. 25).

Guinea Pig; **BIRDS:** Mallard, Canada Goose, Common Egret, Barn Owl, Red-winged Blackbird, Turkey Vulture, Chicken (Murphy *et al.*, 1967). These authors reported that *cantator* females fed on birds and mammals equally, but were not attracted at all to cold-blooded animals.

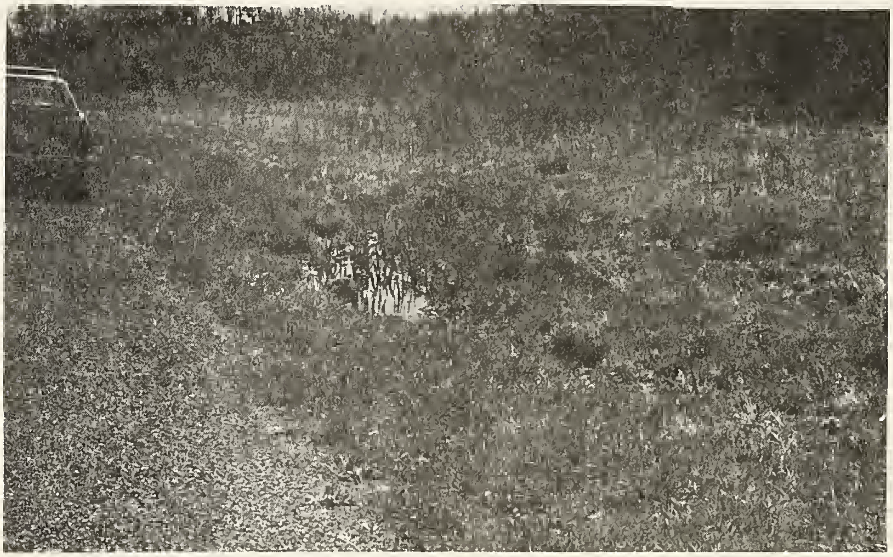
Figure 25. Roadside ditch habitat for larvae of *Aedes cantator*

Adult females of *cantator* attack primarily in the evening and in the open. They do not actively seek opportunities to enter houses, but are attracted to light and enter dwellings readily if they are open. Although females usually feed at night, they attack any time during the day when their resting places in vegetation are disturbed. Smith (1904a) states: "As a biter, *cantator* stands in the front rank, and it is persistent in its attack. It does no unnecessary singing and is not especially deliberate in choosing a point of attack. It proceeds to business at once, and while its bite is not so 'hot' as that of *sollicitans* (i.e., it does not give the intense burning sensation), it is really more painful and more lasting in its effects." Since larvae frequently hatch and develop simultaneously, adults are often encountered in large numbers, especially those of early summer broods. Smith described an encounter with *cantator* and other salt marsh species: "On the morning of July 2nd, I was met when I stepped outdoors by a famished horde containing *sollicitans*, *taeniorhynchus* and *cantator*. The preceding evening we had sat comfortably on the porch, without disturbance from mosquitoes. The incoming horde settled the comfort for weeks thereafter."

In addition to man, *Aedes cantator* has been found to feed readily on the following animals in host preference tests: **MAMMALS:** Woodchuck, Muskrat, Raccoon, Opossum, Red Fox, Meadow Vole, River Otter,

DISTRIBUTION

Aedes cantator occurs along the Atlantic coast of the Northeastern United States south to Virginia and, in Canada, north to Nova Scotia, New Brunswick and Prince Edward Island. In New York, it is common and sometimes abundant in the southeastern counties of Suffolk, Nassau, Richmond, Rockland, Queens and Kings. It has also been collected from brackish and fresh pools and roadside ditches near Syracuse (Onondaga County), Rome and Utica (Oneida County), Ithaca (Tompkins County) and at several locations in brackish water along the New York State Thruway and other highways from New York City to Buffalo.

IMPORTANCE

It has been demonstrated experimentally that *Aedes cantator* can transmit Eastern Encephalitis virus (EE) (Davis, 1940; Merrill *et al.*, 1934). This species, together with *A. sollicitans*, was suspected as a possible vector of the disease in the 1938 epidemic in Massachusetts (Feemster & Getting, 1941; Getting, 1941). However, *cantator* has not been found naturally infected with EE or other arboviruses despite several attempts at isolation (Chamberlain *et al.*, 1958; Sudia *et al.*, 1971). It is sometimes a severe pest in the coastal area of New York.

Aedes (Ochlerotatus) communis (DeGeer)

Culex communis DeGeer, 1776. Mem. Serv. Hist. Ins. 6:316. Type loc.: Europe.
Culex nemorosus Meigen, 1818. Syst. Beschr. zweifl. Ins. 1:4. Type loc.: Europe.
Culex lazarensis Felt & Young, 1904. Science 20:312. Type loc.: Elizabethtown, New York.
Culex borealis Ludlow, 1911. Can. Entomol. 43:178. Type loc.: Alaska.
Aedes altiusculus Dyar, 1917. Insec. Inscit. menstr. 5:100. Type loc.: "Indian Henry's," Mt. Ranier National Park, Washington.

For complete synonymy and additional references, see Stone *et al.* (1959:241-143).

DIAGNOSIS

FEMALE—HEAD: Proboscis dark-scaled; palpi dark with scattered pale scales; occiput with broad median patch of narrow, curved, yellowish to yellowish-white scales and broad, appressed, yellowish-white scales laterally; torus brown to black with white scales on inner surface. **THORAX:** Scutum clothed with reddish, yellowish or grayish scales, with or without submedian stripes or posterior half stripes of reddish-brown to dark-brown scales; postpronotum with narrow yellowish-white scales dorsally, sometimes with patches of reddish-brown to dark-brown scales laterally; pleura with extensive, poorly defined patches of flat grayish-white scales extending on sternopleuron to propleuron and on mesepimeron nearly to lower margin; metameron with pale scales; postcoxal area and hypostigial area without scales; lower mesepimeral bristles two to six, stout. **ABDOMEN:** Tergites brownish black with broad basal bands of cream-colored scales, widened laterally; sternites pale-scaled, usually with scattered dark scales. **LEGS:** Tarsi dark brown, unbanded. **WINGS:** Scales narrow, dark; base of costa usually, and radius occasionally with patch of dark scales.

MALE TERMINALIA—Lobes of ninth tergite longer than broad, each bearing several (four to eleven) short, stout spines. **Tenth sternite** heavily sclerotized on distal half. **Phallosome** broadly conical, notched at apex. **Claspette stem** slender, long, curved, pilose on basal half; **filament** shorter than stem, bladelike, expanded near base, tapered to recurved point at apex, with winglike expansion along outer edge. **Basistyle** 3½ to 4 times as long as wide; **basal lobe** prominent, with many long and short setae and with stout dorsal spine near base; **apical lobe** prominent, thumblike, with many setae. **Dististyle** pilose, with few short subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna about three-fourths as long as head, spiculate; head hairs 5 and 6 long, single (occasionally double). **THORAX:** Prothoracic hair 1 long, single; 2 short, single; 3 short, single or double. **ABDOMEN:** Comb with 30 to more than 70 overlapping scales in triangular patch, each scale bluntly rounded and fringed with four to eight subequal spinules; apical spinules each shorter than distance from its base to point of attachment of scale. **SIPHON:** Siphon index 2.5 to 3.0; pecten teeth evenly spaced; siphonal tuft with four to eight branches, about as long as width of siphon at point of insertion; dorsal preapical spine shorter than apical pecten tooth, inserted at least its length from apex of siphon. **ANAL SEGMENT:** Saddle incomplete, apical spines minute; lateral hair single, shorter than saddle; gills twice as long as saddle or longer, pointed, heavily pigmented.

BIONOMICS

Aedes communis is a common species having the Northern *Aedes* type of life cycle. Larvae are found in temporary snowmelt pools, primarily in forested areas at elevations of 1,500 feet or more. They are locally abundant in wooded areas, especially in coniferous forests, throughout much of upstate New York. Although they are usually found in fresh-water, snowmelt pools, larvae of *communis* have also been reported from brackish water habitats in Alaska (Frohne, 1953). Eggs are deposited under leaves in depressions subject to spring flooding in forested areas. Although Wesenberg-Lund (1921) reported eggs were laid in dry places, it is unlikely they could survive dessication and probably are most often deposited on moist leaves (Barr, 1958). Overwintering eggs begin hatching early in the spring when the pools still contain ice or slush [Horsfall, 1955; Dyar, 1917 (as *A. altiusculus*)]. Hatching is extended over several weeks. First instar larvae have been collected from Dutchess County near the southern limit of its range in New York as early as March 12th, and fourth instar larvae as late as July 26th in Essex County (Barnes *et al.*, 1950), with most larvae present during late April and early May.

The author has found, as reported by Carpenter & LaCasse (1955) that the larvae of *communis* usually occupy the deeper regions of a pool while other species are more commonly found near the edges. Larvae often congregate in a relatively small portion of the site, usually in the sunny portion if possible, and migrate from one part of the pool to the other as the sunlight moves.

Larval development is usually rather slow, sometimes requiring a month or more in the Adirondacks, with 3 to 5 days required for the pupal stage. Larvae developing early in the season usually become larger, resulting in larger adults than those hatching later in May or June, which develop in warm water, It is possible that these small individuals are the autogenic form referred to by Hocking (1952), Vockeroth (1954a) and Barr (1958), since they are collected in abundance in light traps while only the large individuals are collected in biting collections. Most larvae in a pool normally develop at the same rate and emerge within a few hours of each other. Since the larvae often occupy rather small woodland pools and the developmental period is usually long, the water sometimes evaporates, leaving larvae concentrated in a small amount of water or stranded with no water at all. The author has often observed as many as several thousand larvae, all *communis*, concentrated in a small depression holding only a gallon or two of water. Such stranded larvae have been observed to pupate and emerge after a pupal period of about 3 days with only moist soil in the depression.

Adult females are most active at dawn and dusk, with most biting occurring just after dark, although they attack readily during the day in forested areas. The females tend not to leave the woods during the day (Barr, 1958), but after dark are often very numerous in fields adjoining forested areas. They enter dwellings to feed within about a quarter of a mile of the forest. Female *communis* are usually persistent feeders, biting all areas of the body, most often above the knees. On several occasions, the author has found a particular area of the Adirondacks to be apparently free of *communis* one day and be attacked by several hundreds at the same site the following day under the same weather conditions. This indicates that the mosquitoes from a site tend to emerge at the same time. Adults are quite numerous during May and June, then usually decline sharply except in the deepest parts of the forests.

Although there are many records of *A. communis* as a common and annoying pest of man (Nielsen & Rees, 1961; Barr, 1958; Hopla, 1964–65; Steward & McWade, 1961; Natvig, 1948), there are few records of its feeding on other animals. Hopla (1964–65) reported that bears were fed upon readily; Natvig (1948) observed feeding on a nestling grouse in Norway; Thienemann (1938) collected *communis* feeding on lemmings and voles in the Scandinavian arctic. The author has collected *communis* engorging on Whitetail Deer, Porcupine and Red Squirrel in the Adirondacks. It seems likely that this is a general feeder, attacking most available warmblooded hosts. It is not known whether coldblooded animals are also fed upon.

DISTRIBUTION

Aedes communis is distributed throughout the forested regions of northern United States, Canada, Alaska, Siberia, northern Europe and Syria. Rees (1943) and Mail (1934) found it most commonly at high elevations in Montana and Utah. In New York, it is one of the most common and abundant species throughout most of the adirondacks where it is probably the predominant pest species during May. It is also abundant in forested regions throughout much of the State north of Long Island, especially in the Hudson, Mohawk and St. Lawrence River valleys.

IMPORTANCE

Several strains of California Encephalitis virus have been isolated from the *A. communis* group in Wisconsin and Alberta (Sudia *et al.*, 1971). In addition to being an important pest species in forested regions of the State, this species is a potential vector of these viruses.

Aedes (Ochlerotatus) decticus Howard, Dyar & Knab

Aedes decticus Howard, Dyar & Knab, 1917. Mosq. North & Centr. Amer. 4:737. Type loc.: Ontario, Canada.

Aedes pseudodiantaeus Smith, 1952. Bull. Brooklyn Entomol. Soc. 47:21. Type loc.: Belchertown, Massachusetts.

IMPORTANT REFERENCES: Carpenter & LaCasse (1955:170)—resurrected from synonymy with *A. impiger*; Smith (1952:19–40)—bionomics (as *pseudodiataeus*).

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with narrow, curved, pale-yellow scales dorsally, subdorsal patches of dark-brown appressed scales, and broad, appressed, cream-colored scales laterally; torus yellowish to dark brown with a few small, dark setae on inner surface. **THORAX:** Scutum clothed with pale-golden scales, with median, dark-brown stripe or pair of stripes and often a pair of posterior half-stripes; postpronotum with patch of dark, appressed scales; pleura with well-defined patches of flat, appressed, grayish-white scales extending on sternopleuron halfway to propleuron, not reaching lower margin of mesepimeron; postcoxal area, hypostigial area and metameron bare; lower mesepimeral bristles absent. **ABDOMEN:** Tergites dark-scaled with basolateral triangular patches of white scales, but without basal bands; sternites with broad basal bands of white scales, dark apically. **LEGS:** Tarsi dark-scaled, unbanded. **WINGS:** Scales narrow, brown.

MALE TERNINALIA—Lobes of ninth tergite small, about as long as broad, each bearing four or five stout spines. **Tenth sternite** sclerotized and hooked apically. **Phallosome** cylindrical, narrowed and notched apically. **Claspette** distinctive—**stem** stout, curved sharply dorsad near middle, pilose; **filament** slender at base, very broadly expanded beyond base, with two sharp, recurved points apically. **Basistyle** about 3 times as long as wide, slightly concave on outer surface; with a large, dense brushlike tuft of long fine setae near middle on ventral surface and similar smaller tuft near apex; **basal lobe** long, reaching to middle of basistyle, with two stout, curved spines (inner spine longer) arising from common tubercle apically; very long, stout, dorsal spine near base of lobe and several small setae medially; **apical lobe** inconspicuous, broadly rounded, with many short retrorse setae. **Dististyle** pilose, with few setae of medium length near apex.

FOURTH INSTAR LARVA—HEAD: Antenna slender, curved, spiculate about three-fourths as long as head; antennal tuft inserted just before middle of shaft, usually double, reaching apex of antenna; three long subequal and one shorter terminal setae; head hairs 5 and 6 long, single or double (rarely triple). **THORAX:** Prothoracic hair 1 long, single; hairs 2 and 4 minute; 5 to 7 long, single, rarely double or triple. **ABDOMEN:** Comb with 5 to 7 scales in curved row, each scale thornlike with long terminal spine and lateral spinules stronger distally. **SIPHON:** Siphon index 3.5 to 4.0; pecten with one to three distal teeth detached; siphonal tuft 3- to 7-branched, about three-fourths as long as width of siphon at point of insertion; dorsal preapical spine much shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete, extending almost to midventral line, edges sometimes touching but not completely fused, spiculate posterodorsally; lateral hair single, shorter than saddle; ventral brush sparse, with one to three precratal tufts; gils about 1½ to 2½ times as long as saddle, pointed.

BIONOMICS

Aedes decticus is a species having the Northern *Aedes* type of life cycle. According to Mullen (1971), the eggs are laid during June and July on sphagnum or other bog vegetation which becomes submerged during the spring. Eggs hatch in March and early April; larvae have been reported by Smith (1952) from cold sphagnum pools in Massachusetts as early as March 24 and as late as May 15. Mullen reported that second and third instar larvae were abundant in open sunny pools in McLean Bog, Tompkins County on April 13, and fourth instar larvae on April 28, 1967. Pupation normally occurs in early May and adults emerge by mid-May. Mullen observed that immatures were not present in McLean Bog on May 21, but that adult males and females were abundant.

Other mosquito species which have been found most commonly associated with immatures of *decticus* in New York are *Aedes abserratus*, *A. canadensis* and *A. excrucians* in New York (Mullen, 1971). In addition to these, *A. punctor* and *Culiseta morsitans dyari* were found associated in Massachusetts (Smith, 1952). Species less frequently associated include *A. cinereus*, *A. communis*, *A. diantaeus*, *Culex territans*, *Culiseta melanura* and *Anopheles* spp.

Adult females are known only to bite man, but both Smith and Mullen report that the bite is scarcely noticeable. Mullen suggests that the species may be nonanthrophilic, biting man only during periods of peak emergence because of increased competition for normal hosts.

DISTRIBUTION

Aedes decticus is apparently found only in acid bog areas which may limit its range to the northern United States and Canada. It has been reported only from scattered localities in Canada including Labrador, Manitoba and Ontario; Alaska; and the northeastern United States including Massachusetts, Michigan, New Hampshire and New York. In New York, this species has been reported only from McLean Bog in Tompkins County (Mullen, 1971) although it probably occurs in similar habitats in other parts of the State.

IMPORTANCE

Because *decticus* is rare throughout its range, it is of no economic importance.

Aedes (Ochlerotatus) diantaeus Howard, Dyar & Knab

Aedes diantaeus Howard, Dyar & Knab, 1912. Mosq. North & Centr. Amer. 2: pl. 24, fig. 167; 1917. Mosq. North & Centr. Amer. 4:758. Type loc.: Dublin, New Hampshire.

For complete synonymy, see Stone *et al.* (1959: 144).

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi black-scaled; occiput with narrow, curved, pale-yellow scales dorsally and broad, appressed, yellowish-white or cream-colored scales laterally; torus light brown to dark brown with few, small, dark setae on inner surface. **THORAX:** Scutum clothed with pale-golden scales and two narrow, median, brown stripes that are sometimes fused in single, wider stripe; pleura with large, dense, well-defined patches of broad, flat, grayish-white scales extending on sternopleuron nearly to propleuron, covering most of mesepimeron nearly to lower margin; hypostigial area and postcoxal area without scales; metameron usually with few pale scales; lower mesepimeral bristles usually absent, occasionally one or two present. **ABDOMEN:** Tergites dark, purplish brown, scaled with basolateral triangular patches of white scales, usually without pale, basal bands, but occasionally with very narrow bands; sternites white-scaled with dark apical bands. **LEGS:** Tarsi black-scaled, unbanded. **WINGS:** Scales narrow, brown.

MALE TERMINALIA—Lobes of ninth tergite narrowly separated, each with six or seven stout spines. **Tenth sternite** stout, heavily sclerotized, with recurved tips. **Phallosome** cylindrical, narrowed and rounded apically, open ventrally, closed dorsally. **Claspette stem** pilose, stout basally, abruptly constricted near apical fourth, forming a sharp mesally projecting shoulder bearing several small setae; **filament** slender basally, broadly expanded and flattened beyond base with dorsally projecting recurved tip. **Basistyle** stout, about twice as long as wide, outer margin concave; dorsal surface clothed with scales, spicules, long and short setae; ventral surface just beyond middle with dense, brushlike tuft of fine setae surpassing margin of apical lobe; **basal lobe** prominent, conical, reaching to middle of basistyle with two stout, curved spines arising from common apical tubercle and long, stout dorsal spine arising from prominent tubercle near base of lobe; **apical lobe** conical, sharply projecting mesally, bearing retrorse setae. Dististyle broadly expanded medially with three or four small subapical setae; claw short, tapered.

FOURTH INSTAR LARVA—COLOR: Usually yellowish. **HEAD:** Antenna longer than head, slender, gradually darkened and tapered, spiculate, with three long, subequal and one shorter terminal setae; head hairs 5 and 6 with two to five branches, barbed; hair 6 lying in front of line between hairs 5 and 7, forming triangle. **THORAX:** Prothoracic hair 1 long, single; 2 short, single; 3 short, multiple. **ABDOMEN:** Lateral hair 6 double to triple on segment I, single to triple on segment II, single on segments III to VII; comb with 6 to 14 scales in irregular double row, each scale thorn-shaped **without** lateral spinules. **SIPHON:** Siphon index 3.5 to 4.0; pecten with distal 1 to 3 teeth detached; siphonal tuft multiple, about as long as width of siphon at point of insertion; dorsal preapical spine much shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete, spiculate postero-dorsally; lateral hair single, shorter than saddle; gills variable, one to three times as long as saddle, pointed.

BIONOMICS

This species exhibits a Northern *Aedes* type of life cycle, overwintering in the egg stage with one generation a year (Barr, 1958). The immature stages are typically found in cool, shaded, forest snowpools, especially in coniferous forests (Matheson, 1944). They have also been collected from sunny pools in open fields in Norway (Natvig, 1948). Larvae of *diantaeus* are usually sparse and easily overlooked, especially since other species are often more abundant. However, by careful examination of suspected breeding areas, individual larvae are readily recognized by the long antennae and can be selectively collected.

Larvae usually develop during May and adults emerge by late May or early June (Smith, 1952). Fourth instar larvae have been collected from pools in the Adirondacks as early as April 30 and as late as July 26. In the Adirondacks, larvae of *diantaeus* have been found associated with larvae of *Aedes cinereus*, *A. punctor*, *A. fitchii*, *A. communis* and *Culiseta morsitans dyari*.

Adults usually appear in late May or early June although larvae have been collected as late as early July in Minnesota (Owen, 1937) and late July in Lake Placid, New York (Barnes *et al.*, 1950). Practically nothing is known of the habits, or hosts other than man. Owen (1937) reported the females attack man readily any time of day when encountered, but Barr (1958) found that most of Owen's records applied to *punctor* or *communis* rather than *diantaeus*. The author has observed that, while *diantaeus* females bite man, they fly about the host for long periods, often without landing at all. When they land, they usually walk around for some time before feeding, then leave when only partially engorged. *A. diantaeus* adults are normally encountered in the morning and evening in dense woods and usually not in abundance. Since the author has not found females after late June, they may be rather short lived.

DISTRIBUTION

Aedes diantaeus is distributed throughout the forested regions of the Northern Hemisphere including Siberia, Northern Europe, Canada from Nova Scotia to British Columbia, Alaska and northern United States from Maine to Montana and Wyoming (Smith, 1952; Steward & McWade, 1961). This species is rare in New York State and has been collected only from scattered areas in the Adirondacks in small numbers.

IMPORTANCE

Since *A. diantaeus* has not been incriminated in disease transmission and is rare throughout its range, it is of no economic importance.

Aedes (Ochlerotatus) dorsalis (Meigen)

Culex dorsalis Meigen, 1820. Syst. Beschr. zweifl. Ins. 6:242. Type loc.: Germany.

Culex curriei Coquillett, 1901. Can. Entomol. 33:259. Type loc.: Boise, Idaho.

Culex onodagensis Felt, 1904. Bull. N.Y. State Mus. 79:304. Type loc.: Lake Onondaga, Syracuse, New York.

Culex lativittatus Coquillett, 1906. Entomol. News 17:109. Type loc.: Arden, California.

Aedes quaylei Dyar & Knab, 1906. Jour. N.Y. Entomol. Soc. 14:202. Type loc.: California.

Grabhamia mediolineata Ludlow, 1907. Can. Entomol. 39:129. Type loc.: Fort Lincoln, North Dakota.

For complete synonymy and additional references, see Stone *et al.* (1959:144), Carpenter & LaCasse (1955) and Monchadskii (1951).

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark, speckled with pale scales; occiput with median patch of yellowish-white lanceolate scales and submedian patches of brown scales dorsally; broad, appressed, white scales with few scattered dark scales laterally; torus light to dark brown with white scales on inner and dorsal surfaces. **THORAX:** Scutum clothed with yellowish-white lanceolate scales, with median stripe and usually posterior half-stripes of brown lanceolate scales; pleura with large, dense patches of broad, appressed, grayish-white scales extending on sternopleuron to propleuron, entirely covering mesepimeron; hypostigial area, postcoxal area and metameron with pale scales, usually many; lower mesepimeral bristles usually two to six. **ABDOMEN:** Most tergites pale-scaled with pair of small, dark, submedian spots, last two tergites usually entirely white; sternites white-scaled. **LEGS:** Femur, tibia and first tarsal segment white-scaled with scattered dark scales, most other tarsal segments dark-scaled with pale bands apically and basally. **WINGS:** Scales narrow, dark brown and white, with white scales more numerous than dark ones.

MALE TERMINALIA—Lobes of ninth tergite about as long as broad, each with several (four to eight) short, stout spines. **Tenth sternite** heavily sclerotized apically. **Phallosome** conical, broadly rounded apically, longer than wide. **Claspette stem** slender, pilose; **filament** nearly as long as stem, broadly expanded near middle, tapered to recurved tip. **Basistyle** about 3½ times as long as wide; basal lobe prominent, quadrangular, somewhat expanded distally, bearing short, stout spine, long recurved spine and many long and short fine setae; **apical lobe** short, rounded. **Dististyle** pilose, with few short subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head, spiculate; head hairs 5 and 6 long, single (occasionally double or triple), sparsely barbed. **THORAX:** Prothoracic hair 1 long, single; 2 short, single; 3 short, 1- to 5-branched. **ABDOMEN:** Comb with 18 to 35 scales in patch, each scale blunt, fringed with subequal spinules. **SIPHON:** Siphon index about 2.0 to 3.0; pecten teeth evenly spaced; dorsal preapical spine shorter than outer pecten tooth. **ANAL SEGMENT:** Saddle incomplete; lateral hair ussally single (occasionally double), usually much shorter than saddle; ventral brush well developed with two to five precratal tufts; gills short and budlike to three times as long as saddle, varying with salinity of water.

BIONOMICS

Aedes dorsalis is classified by Pratt (1959) as having a "temporary pool" type of life cycle. Females produce an average of about 130 eggs which are deposited in batches of from one to six in moist soil of shallow depressions subject to subsequent flooding. They usually die after oviposition and are not known to deposit a second batch of eggs (Rees & Nielsen, 1947). Overwintering is in the egg stage and the first larvae normally appear in early May with the onset of prolonged warm weather in New York. Hatching has been shown to be dependent upon a reduction of dissolved oxygen as with *A. sticticus* and *A. vexans* (Gjullin *et al.*, 1941).

Larvae are adapted to breeding in fresh and brackish water. They are commonly found in tidal marshes on the Pacific Coast (Quayle, 1906; Rees & Nielsen, 1947) and in saline and freshwater marshes and temporary pools as well as the edges of the Great Salt Lake in Utah (Rees & Nielsen, 1947). This is primarily a species of the plains and prairies (Hearle, 1929; Rees & Nielsen, 1947), but is also found in mountain snowpools at lower altitudes (Rees, 1943). Larvae are usually found in shallow grassy pools exposed to direct sunlight, but also occur in lightly shaded woodland pools. Hearle (1929, 1932) and Rees & Nielsen (1947) reported that larvae are most often found in water having high alkali content, up to 12 percent by weight.

The author has collected larvae from saline water in several areas of the State, including tidal salt marsh, grassy roadside pools along the main highways, semipermanent weedy pools in the vicinity of salt mines and wells, and temporary vegetation-free pools of summer rainwater in creek beds near a salt mine. The presence of *dorsalis* larvae, as well as *A. sollicitans*, in drainage ditches and pools along the New York State Thruway and other main highways may be due, at least in part, to the use of large amounts of salt to clear ice from the roads in winter (fig. 26).

Later instar larvae of *dorsalis* are easily driven to the bottom of a pool where they often lie quietly in a prone position, hidden beneath rocks, vegetation or debris. They are very difficult to detect or collect in this position, especially if the pool is encrusted with salt or other minerals or contains "sheets" of algae as is often the case. The larvae are most easily collected by waiting for them to surface, which they normally do within about five minutes.

The females of *dorsalis* are vicious biters and attack anytime during the day or night, but especially in early evening or on calm cloudy days (Rees, 1943). If interrupted during feeding, the female will attack the same or another host persistently until replete (Rees & Nielsen, 1947). Man and large mammals such as horses, cows and sheep are the preferred hosts, but the females also attack large birds if no mammalian hosts are available.

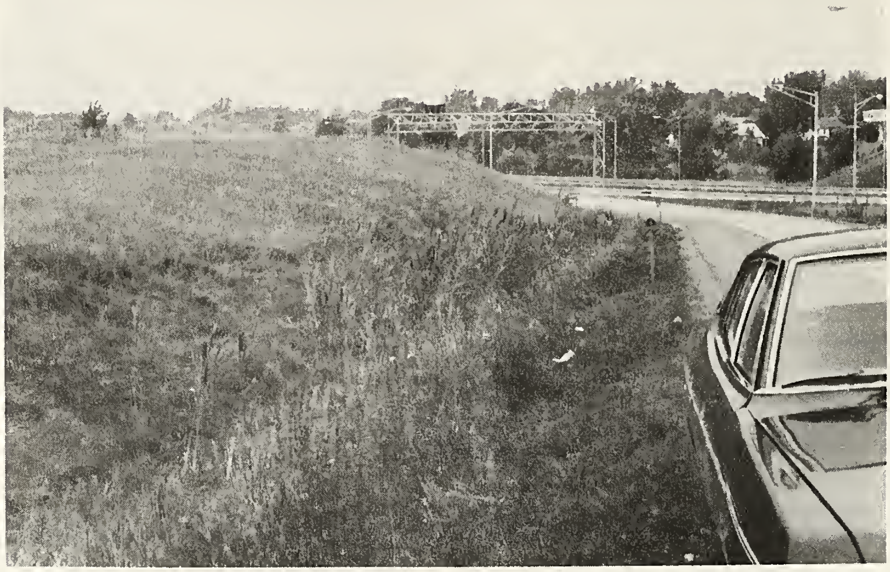

Figure 26. Roadside ditch containing brackish water, habitat for larvae of *Aedes dorsalis* and *A. sollicitans*

DISTRIBUTION

Aedes dorsalis is widely distributed throughout northern Europe and Asia, northern Africa, the plains regions of Canada and the unforested regions of the United States from the Atlantic and Gulf coasts to the Pacific, being most abundant in the northern plains states (Rees & Nielsen, 1947; Rees, 1943; Horsfall, 1955). In New York, it has been found in widely scattered localities south of the Adirondacks. It appears to be most common and abundant in the western and mid-western counties of Genesee, Schuyler and Onondaga.

IMPORTANCE

The viruses of both California Encephalitis (Sudia *et al.*, 1971) and Western Encephalitis (Hammon & Reeves, 1945; Spalatin *et al.*, 1963; Thompson *et al.*, 1951) have been isolated on several occasions from natural populations of *Aedes dorsalis.* Although the species is not usually found in abundance in New York, it is considered medically important.

Aedes (Ochlerotatus excrucians (Walker)

Culex excrucians Walker, 1856. Ins. Saund. Dipt. 1:429. Type loc.: Nova Scotia, Canada.

Culex siphonalis Grossbeck, 1904. Can. Entomol. 36:322. Type loc.: Livingston Park, New Jersey.

Culex abfitchii Felt, 1904. Bull. N.Y. State Mus. 79:381. Type loc.: Karner, New York.

Aedes sansoni Dyar & Knab, 1909. Can. Entomol. 41:102. Type loc.: Banff, Alberta, Canada.

Aedes euedes Howard, Dyar & Knab, 1912 (1913). Mosq. North & Centr. Amer. 2: pl. 28, fig. 191; 1917. Mosq. North & Centr. Amer. 4:714. Type loc.: Trenton, Ontario, Canada.

Aedes riparius, of Dyar (not Dyar & Knab), 1924. Insec. Inscit. menstr. 12:41. (Harmston & Lawson 1967, syn.).

For additional synonymy, see Stone *et al.* (1959: 145).

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled with scattered pale scales; occiput with median patch of narrow, yellowish-white scales and submedian patches of dark scales dorsally, with broad, appressed, whitish scales and small patches of dark-brown scales laterally; torus yellow to brown with patch of white scales on inner surface. **THORAX:** Integument of scutum dark brown to black, clothed with yellowish-white scales with median stripe of brown scales (occasionally completely clothed with reddish-brown scales). Pleura with sparse but distinct patches of grayish-white scales, extending on sternopleuron nearly to propleuron, covering upper two-thirds of mesepimeron; postcoxal area and metameron with pale scales; hypostigial area bare; lower mesepimeral bristles usually absent (occasionally one). **ABDOMEN:** Tergites dark brown with basal white bands and few scattered white scales; sternites pale-scaled with few dark scales medially. **LEGS:** Most tarsal segments with pale basal bands twice as long as wide or longer; tarsal claw of foreleg with primary tooth long and straight, accessory tooth parallel to it, longer than distance between tips of the two teeth. **WINGS:** Scales narrow, predominantly dark with a few pale scales intermixed, mostly on anterior veins.

MALE TERMINALIA—Lobes of **ninth tergite** broadly rounded, each with four to eight long, slender spines. **Tenth sternite** heavily sclerotized distally. Phallosome expanded medially, longer than wide, notched at apex. **Claspette** stem long, slender, pilose basally; **filament** shorter than stem, sharply expanded, forming an angle near base, recurved apically. **Basistyle** about 3 times as long as wide; **basal lobe** represented by a broad expansion reaching nearly to base of apical lobe, clothed with numerous small setae arising from tubercles; **apical lobe** broadly rounded, clothed with numerous small setae. **Dististyle** expanded medially, with few subapical setae; claw slender.

FOURTH INSTAR LARVA—COLOR: Pale, sometimes with greenish cast. **HEAD:** Antenna two-thirds to three-fourths as long as head, slender, spiculate; head hairs 5 and 6 usually double, occasionally triple. **THORAX:** Prothoracic hair 1 long, single; 2 short, single; 3 short, single to triple. **ABDOMEN:** Lateral hair 6 usually double on segments I and II, single on segments III to VI; hair 1 on segments IV, V and VII conspicuously long, usually single; comb with 15 to 35 scales in patch, each scale thornlike with lateral spinules and long terminal spine. **SIPHON:** Siphon index about 4.0 to 5.0; pecten usually with distal one to three teeth detached; siphonal tuft longer than width of siphon at point of insertion; dorsal preapical spine shorter than outer pecten tooth; ventral valves each with a strongly curved seta, as long as valve or longer. **ANAL SEGMENT:** Saddle incomplete; lateral hair single, about as long as saddle; ventral brush well developed, with three to five precratal tufts; gills variable, from less than one to three times as long as saddle.

BIONOMICS

Aedes excrucians is one of the most widely distributed and, with *A. fitchii* and *A. stimulans*, one of the most common Northern *Aedes* species in New York. Overwintering eggs hatch in early April and fourth instar larvae and pupae are usually found, though not in great abundance, from mid-April to mid-May throughout the State. This is sometimes extended through late May or early June at higher elevations, as late as June 25th in the Adirondacks.

In New York, larvae are usually found in cool, temporary, shallow grassy pools with scattered shade, especially in the vicinity of coniferous forests. The author has also collected this species from a variety of temporary and semipermanent freshwater habitats, including dark spruce and sphagnum bogs, hardwood swamps, open fields and grassy roadside ditches, as well as saline pools on Long Island and in the vicinity of salt mines in central New York (fig. 27).

As reported by Wesenberg-Lund (1921), larvae beyond first instar are most often found either on the bottom of the pool or partway between the bottom and the surface, infrequently on the surface. For this reason, they are often difficult to collect using standard dipping methods. They are easily collected by either (1) holding a white enamel dipper motionless beneath the water surface and allowing the larvae to swim into it as recommended for *A. fitchii* by Siverly (1972) or (2) thrusting the dipper into the leaves and other debris on the bottom, transferring the water and debris to a white enamel pan, removing the leaves and collecting the larvae with a large bulb syringe.

In New York, *A. excrucians* larvae are most often associated with larvae of *A. canadensis*, *fitchii*, *trichurus* and *stimulans*. Other species which are sometimes found associated include *A. cinereus*, *diantaeus*, *abserratus*, *punctor*, *vexans* and *decticus* (Mullen, 1970).

Adult females bite anytime during the day or evening in wooded or shaded places and at night in open areas. Together with *A. stimulans* and *fitchii*, with which they are often found associated and are confused morphologically, *excrucians* constitutes a high percentage of the mosquito annoyance in the forested regions of upstate New York (Jamnback, 1969). These three species are often found in houses near their breeding areas and frequently comprise more than half of the annoying buzzing and biting at night, especially in late June and early July.

Little is known regarding the hosts of *A. excrucians* other than human. Means (1968) reported that it fed on both birds and mammals, but not on reptiles or amphibians. Wright & DeFoliart (1970) reported similar results for the *A. stimulans* group, including *excrucians*. Hosts reported by these authors and additional unrecorded hosts observed by the author in the Adirondacks are: **MAMMALS:** Whitetail Deer, Raccoon, Red Fox, Opossum, Domestic Rabbit, Eastern Cottontail, Beaver, Woodchuck, Gray Squirrel, Red Squirrel, Porcupine, White-footed Mouse; **BIRDS:** Chicken, Woodcock, Bobwhite, Ring-necked Pheasant.

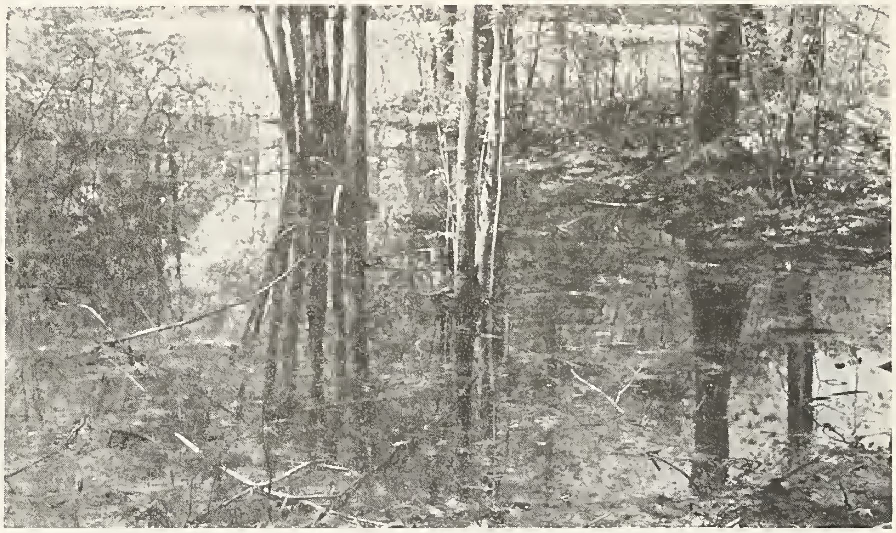

Figure 27. Typical woodland pool habitat for larvae of *Aedes excrucians*, *A. fitchii*, and other Northern *Aedes* mosquito species

DISTRIBUTION

Aedes excrucians occurs in northern Europe and Asia and is distributed throughout most of the forested regions of Canada, and northern United States from Alaska south to Connecticut, Rhode Island, Pennsylvania, Illinois and the mountain states of Wyoming and Colorado. In New York, it is moderately abundant in the northern counties of St. Lawrence, Clinton and Franklin and in the higher elevations of the Adirondacks, Catskills, and the Allegheny Plateau. It has also been reported from other areas but is not usually common. It is rare in the southern counties and on Long Island.

IMPORTANCE

California Encephalitis virus has been isolated from pools of *Aedes stimulans* group mosquitoes which included *excrucians* (Hoff *et al.*, 1969; Iverson *et al.*, 1969). Yen (1938) and Phillips (1939) found that *A. stimulans*, and probably also *excrucians*, could serve as intermediate hosts and vectors of Dog Heartworm, *Dirofilaria immitis*. These species, however, are univoltine and occur primarily in the spring and early summer; therefore, they may not be present long enough to act as vectors. *A. excrucians* may be an important pest species in forested areas of the State in late spring and early summer.

Aedes (Ochlerotatus) fitchii (Felt & Young)

Culex fitchii Felt & Young, 1904. Science 20:312. Type loc.: Karner, New York.
Aedes palustris Dyar, 1916. Insec. Inscit. menstr. 4:89. Type loc.: Fallen Leaf, Lake Tahoe, California.
Aedes palustris var. *pricei* Dyar, 1917. Insec. Inscit. menstr. 5:16. Type loc.: California.
Aedes mimesis Dyar, 1917. Insec. Inscit. menstr. 5:116. Type loc.: Drummond, Montana.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark, with scattered pale-white to yellowish scales, palpi sometimes with pale bands at bases of segments III and IV and at apex of terminal segment; occiput with median patch of narrow, yellow scales and submedian patches of brown to golden-yellow scales dorsally; broad, appressed pale-yellow scales and small patches of brownish scales laterally; torus yellow to brown with pale-yellowish to white scales on inner surface. **THORAX:** Scutum dark brown with median stripe (and usually posterior half-stripes) of brown to yellowish-brown scales and with yellowish-white to gray scales laterally, anteriorly and in prescutellar space; pleura with sparse, extensive patches of grayish-white scales, extending on sternopleuron to propleuron, well separated from prealar patch covering upper two-thirds of mesepimeron; postcoxal area and metameron with pale scales, hypostigial area bare; lower mesepimeral bristles none to two (rarely three to four). **ABDOMEN:** Tergites brown-scaled with broad, basal, white bands, usually widened medially; usually with scattered pale scales medially and posteriorly, sometimes forming longitudinal stripe and occasionally covering entire dorsal surface of abdomen; sternites pale-scaled with few dark scales intermixed. **LEGS:** Femora and tibiae conspicuously clothed with brown and yellowish-white scales intermixed; most tarsal segments with broad, basal, white bands; tarsal claws with primary tooth strongly curved, secondary tooth divergent from it and shorter than distance between tips of two claws. **WINGS:** Scales narrow, brown and yellowish-white intermixed, pale scales predominating, especially on anterior veins.

MALE TERMINALIA—Lobes of ninth tergite about as long as broad with long, strong spines, **tenth sternite** heavily sclerotized distally. **Phallosome** subcylindrical, wider at base than at apex, notched at apex. **Claspette stem** long, slender, pilose on basal half; **filament** shorter than stem, bladelike, notched near base, strongly recurved at apex. **Basistyle** about 3 times as long as width at middle, **basal lobe** prominent, triangular, densely clothed with setae, with stout dorsal spine near base; **apical lobe** prominent, clothed with setae. **Dististyle** slightly expanded medially, pilose, with few subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head, spiculate; head hairs 5 and 6 long, 2- to 4-branched. **THORAX:** Prothoracic hair 1 long, single to triple, usually double; 2 long, single; 3 medium, single or double. **ABDOMEN:** Lateral hair 6 double to triple on segments I and II, double on segments III to VI; comb in patch of 8 to 30 scales, usually 12 to 24, each scale thornlike with lateral spinules and long terminal spine. **SIPHON:** Siphon index 4.0 to 5.0; pecten teeth evenly spaced; siphonal tuft usually much longer than width of siphon at point of insertion; ventral valves of siphon each with strongly curved seta at least as long as valve. **ANAL SEGMENT:** Saddle incomplete, spiculate posteriorly; lateral hair single, longer than saddle; gills one to three times as long as saddle, pointed.

BIONOMICS

Aedes fitchii is one of the most common Northern *Aedes* species in New York, moderately abundant everywhere except on Long Island where it is present only in scattered localities. This species is apparently univoltine (Owen, 1937; Siverly, 1972), but larvae have been collected in the Adirondacks as late as July 28, probably from late hatching eggs. Overwintering eggs apparently begin hatching in the southern part of the State about mid-April, 1 to 2 weeks later than *A. excrucians*. Third instar larvae have been collected by April 15 in Suffolk County. First instar larvae are usually found by mid-April in the central portion of the State around Albany and by April 20 in the northern and mountainous regions.

Larvae are found in a variety of temporary and semipermanent habitats ranging from open grassy ditches and cattail marshes to dark spruce and sphagnum bogs. Matheson (1944) reported that larvae of *fitchii* frequently occurred in immense numbers in shallow pools having dense leaf-covered bottoms, while Carpenter & LaCasse (1955) stated that they prefer deeper, more permanent pools. The author has collected this species from temporary snowmelt pools and deep, semipermanent pools, in shaded bogs and in the open sun. In all types of habitats, the larvae are often very abundant. Like *A. excrucians*, they are not often found at the surface of the water. For this reason, they are most easily collected either by holding a white dipper motionless beneath the water surface, allowing the larvae to swim into it, or by thrusting the dipper into the leaves and debris lining the bottom of the pool.

The larvae of *fitchii* are often associated with several other mosquito species. In New York, the most frequent associates are *A. stimulans* and *A. excrucians*. Other species with which it is commonly associated include *A. abserratus*, *A. canadensis*, *A. communis*, *A. intrudens*, *A. punctor*, *A. trichurus*, *A. vexans*, *Culiseta morsitans dyari* and *C. inornata*.

Aedes fitchii females attack humans persistently during the day, especially in and at the edge of wooded areas, and in the evening. Freeborn (1926) stated that they usually become quiet after dark, but sometimes continue biting actively on bright, moonlit nights. The author has found that females often enter dwellings to feed, especially on hot, humid nights and usually cease activity when it becomes dark. Downe (1960) and Wright & DeFoliart (1970) have shown that this species (included in the *A. stimulans* group) has a preference for humans and large domestic and wild animals. It also feeds to some extent on a variety of warm-blooded woodland vertebrates including birds. The host records include the following species: **MAMMALS:** Whitetail Deer, Raccoon, Red Fox, Opossum, Domestic Rabbit, Eastern Cottontail, Beaver, Woodchuck, Gray Squirrel, Fox Squirrel, Chipmunk, Ground Squirrel; **BIRDS:** Chicken, Woodcock.

DISTRIBUTION

A. fitchii is distributed throughout the forested regions of Canada and Northern United States south into the Mountain States of Colorado and Wyoming, north to Alaska. In New York, it is most common and abundant in St. Lawrence, Clinton and Franklin counties, the Adirondacks and other heavily forested regions. It is also common and often quite abundant in small local forested areas throughout the State. It is present on Long Island only in scattered localities.

IMPORTANCE

In the mountains and northern regions of the State where *fitchii* reaches its greatest abundance, and in suburban areas where it is sometimes locally abundant, it can cause great discomfort to residents, sportsmen and campers in early summer through about the middle of July. In addition to being a pest, this species has been incriminated as a possible vector of canine filariasis *(Dirofilaria immitis)* (Ludlam *et al.*, 1970; Bemrick & Sandholm, 1966) and California Encephalitis group viruses (Sudia *et al.*, 1971; Hoff *et al.*, 1969; Iverson *et al.*, 1969). *Aedes fitchii* is considered a medically important species as a potential vector and a severe pest in some areas.

Aedes (Ochlerotatus) flavescens (Müller)

Culex flavescens Müller, 1764. Fauna Insect. Fridrichsdalina: 87. Type loc.: Unknown.

Culex flavescens Theobald, 1901: Monogr. Cul. 1:410. Type loc.: Unknown.

Culex fletcheri Coquillett, 1902. Proc. U.S. Nat. Mus. 25:84. Type loc.: Carnduff, Assiniboia, Saskatchewan, Canada.

For complete synonymy and additional references see Stone *et al.* (1959: 145).

IMPORTANT REFERENCE: Hearle (1929)—bionomics.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi brown with scattered yellow scales; occiput with narrow, golden to yellowish scales dorsally, broad, appressed, light-yellow to cream-colored scales laterally; torus brown with yellowish scales on inner surface. **THORAX:** Scutum clothed with yellow to light-brown scales laterally, usually with broad, median stripe of reddish-brown to dark-brown scales (sometimes indistinct); pleura with extensive patches of yellowish-white scales, usually giving rough appearance, extending on sternopleuron to propleuron, narrowly separate from prealar patch and to lower margin of mesepimeron; postcoxal area, hypostigial area and metameron with yellowish scales; lower mesepimeral bristles usually absent (occasionally one or two). **ABDOMEN:** Tergites densely clothed with overlapping dull-yellowish scales, occasionally with broad, yellowish-white basal bands, sternites clothed with dull-yellow scales. **LEGS:** Most tarsal segments with broad, basal bands of yellowish-white scales, dark apically. **WINGS:** Scales narrow, mostly yellow with some brown intermixed.

MALE TERMINALIA—Lobes of ninth tergite short, narrow, each with six or seven long spines. **Tenth sternite** heavily sclerotized apically. **Phallosome** subcylindrical, wider at base than apex, notched at apex. **Claspette stem** short, stout, tapered distally, pilose, with three long spines mesally near base; **filament** about as long as stem, narrow on basal third, with broad, bladelike, median expansion, tapered to a recurved tip. **Basistyle** about 2½ times as long as width at middle; **basal lobe** represented by a large area clothed with fine setae, elevated basally, gradually tapered down to beyond middle of basistyle, with stout dorsal spine near base; **apical lobe** prominent, rounded apically, clothed with many setae. **Dististyle** slightly expanded medially, pilose, with three or four small subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna less than half as long as head; head hairs 5 and 6 with two to four branches. **THORAX:** Prothoracic hair 1 long, single; 2 medium, single; 3 short, 2- to 4-branched. **ABDOMEN:** Comb scales 20 to 40 in a patch, each scale thornlike with lateral spinules. **SIPHON:** Siphon index about 3.0 to 4.1; pecten not reaching middle of siphon, teeth either evenly spaced or with distal one or two teeth detached; dorsal preapical spine much shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete; lateral hair about as long as saddle; gills from half as long as saddle to twice as long.

BIONOMICS

A detailed account of the biology of *Aedes flavescens* is given by Hearle (1929). This species breeds primarily in the Plains States and plains areas of Canada where it is one of the most common species (Twinn, 1949). It is rare in New York State. Overwintering occurs as fully developed embryos within the eggs which are laid on damp vegetation or earth lining depressions in open areas. There is probably one generation a year with most of the eggs hatching in late April to early May. Hearle reported that hatching is sometimes uneven and occurs over a period of several months and Rempel (1953) reported that there is often a second brood of larvae in August in Saskatchewan. A single larva reported from New York was collected on July 26, 1945 in the Adirondacks (Barnes *et al.*, 1950). Larvae are found typically in semipermanent pools of moderate depth which contain considerable vegetation in treeless areas (Hearle, 1929; Siverly, 1972). Rempel (1953) reported that breeding is abundant in prairies which are flooded in the spring and dry later. These prairies are used by cattle for grazing, thereby providing hosts for the adult mosquitoes. Hearle observed that young larvae feed at the water surface, but that fourth instar larvae are usually concealed on the bottom and are rarely seen on the surface.

Females live for as long as 6 weeks and are collected from late May until mid-August (Hearle, 1929). They attack man and larger mammals such as horses and cows readily (Hearle, 1929; Wesenberg-Lund, 1921). Rempel *et al.* (1946) reported that they feed about equally on man and horses and to a lesser extent on birds and cows in Saskatchewan.

DISTRIBUTION

Aedes flavescens occurs in the interior plains of the northern Holarctic region—Europe, Asia, United States south to northern Illinois and Iowa, Canada north to Hudson Bay and Alaska. The species has been reported only three times from New York, a single larva from Lake Placid, Essex County; a male from Ithaca, Tompkins County and a male from Albany, Albany County (Barnes *et al.*, 1950).

IMPORTANCE

Although *Aedes flavescens* is a pest of major importance in the plains areas of Minnesota and other Plains States and the plains areas of Canada, it is rare and of no importance in New York.

Aedes (Ochlerotatus) grossbecki Dyar & Knab

Aedes grossbecki Dyar & Knab, 1906. Jour. N.Y. Entomol. Soc. 14:201; Howard, Dyar & Knab, 1917. Mosq. North & Centr. Amer. 4:708. Type loc.: New Jersey.

Culex sylvicola Grossbeck, 1906. Can. Entomol. 38:129. Type loc.: Livingston Park, New Jersey.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark brown to black with scattered white scales; occiput with broad, median patch of narrow white scales and submedian dark patches dorsally; broad, appressed, white scales and small, dark patches laterally; torus brown with white scales on inner surface. **THORAX:** Integument of scutum dark brown to black with broad median stripe and usually posterior half-stripes of golden-brown to dark-brown scales; lateral, anterior and prescutellar regions with white scales; pleura with small, dense patches of grayish-white scales, extending on sternopleuron halfway to propleuron, not reaching lower margin of mesepimeron; postcoxal area and metameron with pale scales; hypostigial area bare; lower mesepimeral bristles 0 to 3 (usually 2 to 3). **ABDOMEN:** Tergites black-scaled with broad basal bands of yellowish-white scales and usually with scattered yellowish scales on apical half; sternites pale-scaled, speckled with few dark scales. **LEGS:** Most tarsal segments with broad basal bands of yellowish scales. **WINGS:** Scales broad, triangular, intermixed dark and white.

MALE TERMINALIA—Lobes of ninth tergite about as long as broad, each with several (5–10) long spines. **Tenth sternite** heavily sclerotized apically. **Phallosome** conical, about twice as long as width at base, notched at apex. **Claspette** stem slender, pilose; filament shorter than stem, with broad, bladelike median expansion, tapered to a recurved tip. **Basistyle** about 3½ times as long as width at middle; **basal lobe** prominent, conical, with numerous small apical setae and long stout dorsal spine; **apical lobe** prominent, with many long fine setae. **Dististyle** slightly expanded medially, with a few short subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna almost half as long as head; head hairs 5 and 6 usually triple (occasionally with 2 to 4 branches). **THORAX:** Prothoracic hair 1 long, single; 2 medium, single; 3 short, single or double. **ABDOMEN:** Abdominal hair 1 of segments IV and V almost as long as hair 6; comb scales 25 to 35 in patch, each scale fringed with subequal spinules. **SIPHON:** Siphon index about 3.5; pecten teeth evenly spaced; dorsal preapical spine about as long as apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete, spiculate with strong spinules surpassing apical margin; lateral hair slightly shorter than saddle; gills about as long as saddle, pointed.

BIONOMICS

Aedes grossbecki has a typical Northern *Aedes* type of life cycle, overwintering in the egg stage with a single generation a year (Siverly, 1972; Wirth, 1947). The larvae are found in early spring in woodland pools, roadside ditches and deep bogs (Carpenter & LaCasse, 1955; Siverly, 1972). Siverly found larvae in abundance in Indiana in shallow pools lined with hardwood leaves in April, although they were much less abundant than *A. canadensis.* Larvae are moderately abundant in large woodland pools in Delaware in early April (R. Lake, Univ. of Delaware, pers. comm., 1974). Other species with which larvae are commonly associated in the northern part of its range include *Aedes canadensis* and *A. stimulans* (Siverly, 1972; Horsfall, 1955; Lake, pers. comm., 1974).

Aedes grossbecki females are vicious biters which attack readily day or night (Siverly, 1972). They are also known to feed on dogs (Carpenter & LaCasse, 1955; Siverly, 1972); no other hosts have been reported.

DISTRIBUTION

This species occurs in the southeastern United States west to Arkansas and Louisiana, north to New York and Massachusetts. Records indicate it is rare throughout its range; however, Dr. Robert Lake (University of Delaware, Newark, Delaware, pers. comm., 1974) has found it to be common in Delaware. It is rare in New York and has been reported only from Ithaca, Tompkins County (Matheson, 1944), Hempstead, Nassau County, (1 male) and Orangeburg, Rockland County, (1 male) (Barnes *et al.*, 1950). Females labeled as *A. grossbecki* in the New York State Museum collection were collected from Old Forge, Hamilton County (1904), Delmar, Albany County (1904) and Keene Valley, Essex County (1889), but the specimens are in poor condition and identification cannot be confirmed.

IMPORTANCE

Although this species is a vicious biter, it has not been incriminated in disease transmission. It is of no economic importance in New York.

Aedes hexodontus Dyar

Aedes hexodontus Dyar, 1916. Insec. Inscit. menstr. 4:83. Type loc.: Fallen Leaf, Lake Tahoe, California.

A. hexodontus occurs in the arctic tundra and alpine meadows primarily in Canada, Alaska and the northwestern United States southward into the mountain ranges of Colorado (Carpenter & LaCasse, 1955; Harmston & Lawson, 1967; Gjullin & Eddy, 1972) as well as northern Europe and Asia (Vockeroth, 1954a). It occurs mostly at 8,000 feet or more elevation (Harmston & Lawson, 1967; Smith, 1966), but Jenkins & Knight (1950) have collected larvae from snowmelt pools and rockpools at 1,000 feet elevation at Great Whale River, Quebec. *A. hexodontus* has not been identified from New York, however, larvae collected in the Adirondacks and tentatively identified as *Aedes punctor* closely resemble hexodontus and it is possible that this species might occur at the higher elevations in the State.

Harmston & Lawson state that the species is univoltine and that the larvae are usually found in mountainous areas above 8,000 feet, in snowmelt pools in open, marshy meadows. Females emerge very early in the season (Jenkins & Knight, 1950), but some hatching is delayed with late instar larvae present at 9,000 feet elevation in the Gothic Colorado area until the end of July (Smith, 1966). Smith found larvae in wet open meadows and in stream overflow areas.

The females have been described as persistent biters and important pests at higher elevations by Harmston & Lawson (1967), Jenkins & Knight (1950) and Gjullin & Eddy (1972). Smith (1966) found them to bite only occasionally.

Aedes (Ochlerotatus) impiger (Walker)

Culex impiger Walker, 1848. List Dipt. Brit. Mus. 1:6. Type loc.: Ontario, Canada.

For complete synonymy, distribution and bionomics, see Vockeroth (1954b).

This species has not been reported from New York State. *Aedes impiger* (Walker) of Matheson (1944) and of Barnes *et al.* (1950) (=*Aedes implicatus* Vockeroth, 1954) was a misidentification. It is found in the arctic regions of Alaska, Canada, Scandinavia and Siberia and in the northwestern United States, southward into Utah and Colorado at higher elevations. The larvae are usually found in clear snowpools in arctic alpine conditions at elevations of 7,000 feet or more (Carpenter & LaCasse, 1955) although they have also been collected in alpine meadows at Great Whale River, Quebec, at elevations of less than 1,000 feet (Jenkins & Knight, 1950).

Jenkins & Knight (1950), Mail (1934) and Harmston & Lawson (1967) all report that the females bite man readily and may be a nuisance in localized areas, but that it is too rare and occurs at too high an altitude to be considered important.

Aedes (Ochlerotatus) implicatus Vockeroth

Aedes implicatus Vockeroth, 1954. Can. Entomol. 86:110. Type loc.: Quebec, Canada.
Aedes decticus Howard, Dyar & Knab, 1919 (partim.) Insec. Inscit. menstr. 7:21. Type loc.: White River, Ontario, Canada.
Aedes impiger, authors, not Walker.

Aedes implicatus was described by Vockeroth (1954b) for specimens misidentified as *A. impiger* (Walker) by several authors (Barnes *et al.*, 1950; Matheson, 1923, 1944; Dyar, 1920, 1921b, 1922; Gjullin 1946; Rempel, 1950 and others). The real *A. impiger* (Walker) (described by Dyar as *A. nearcticus*) occurs much farther north, primarily in the arctic region and has not been found in New York. For complete synonymy and additional references for both species, see Vockeroth (1954b).

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with narrow, white scales dorsally, broad, appressed, white scales and dark patches laterally; torus yellow to black, usually with a patch of white scales on inner surface. **THORAX:** Scutum clothed with coppery-brown scales and broad, median stripe or pair of stripes of reddish-brown to dark-brown scales and with grayish-white scales on lateral and anterior margins and in prescutellar space; pleura with dense patches of broad, grayish-white scales, extending on sternopleuron halfway to propleuron, narrowly separate from prealar patch, extending on mesepimeron nearly to lower margin; postcoxal area and metameron with pale scales; hypostigial area sometimes with few pale scales; lower mesepimeral bristles one to three, rarely more. **ABDOMEN:** tergites brown-scaled with basal, white bands, variable in width; sternites white-scaled. **LEGS:** Tarsi dark-scaled, unbanded. **WINGS:** Scales narrow, dark with patch of white scales at base of costa.

MALE TERMINALIA—Lobes of ninth tergite broader than long, each with four to eight stout spines. **Tenth sternite** heavily sclerotized apically. **Phallosome** cylindrical, open ventrally except at base, notched at apex. **Claspette stem** slender, curved, pilose; **filament** shorter than stem, extended to a sharp angle near base, bladelike, tapered to sharp point apically. **Basistyle** 3½ to 4 times as long as wide; **basal lobe** prominent, conical, with numerous fine setae, an apical row of long, stout setae and a strong dorsal spine; **apical lobe** prominent, thumblike. **Dististyle** pilose, somewhat broader medially, with several subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head; head hair 5 long, single or double; 6 long, single; head capsule dark brown (light brown on *communis*). **THORAX:** Prothoracic hair 1 long, single; 2 medium, single; 3 short, usually single or double. **ABDOMEN:** Comb scales 15 to 30, well separated and distinct, with apical spinules longer than distance from their bases to attachment of scale. **SIPHON:** Siphon index 3.0 to 3.5; pecten teeth evenly spaced; dorsal preapical spine shorter than apical tooth. **ANAL SEGMENT:** Saddle incomplete with apical spines larger and more thornlike than those at base; lateral hair usually single, shorter than saddle; gills usually 1 to 1½ times as long as saddle, blunt or pointed, pigmented.

BIONOMICS

Aedes implicatus is a univoltine species with a typical Northern *Aedes* type of life cycle which occurs primarily in Canada and at high elevations in the northern United States. Larvae are found in temporary pools, usually snowmelt pools in forested regions, often along streams among growths of willows at elevations of 6,000 to 9,000 feet in Colorado and Utah (Harmston & Lawson, 1967; Rees & Nielsen, 1951). Barr (1958) found the larvae most often in very cold, melted snowwater overlying frozen ground, and in semipermanent water. Frohne (1953) reported breeding in brackish water in Alaska.

Larvae of *implicatus* are the first to appear in central Alaska where adult emergence is at a peak by middle to late May (Gjullin *et al.*, 1961). In the mountains of Colorado and Utah, larvae are among the earliest, appearing about mid-May at elevations of 8,000 feet (Harmston & Lawson, 1967). Barr (1958) also found larvae appearing very early in Minnesota, after *spencerii* and *intrudens* but earlier than *communis* and *trichurus*. Matheson (1944) reported they were the first to appear in central New York in late March.

Adult females are reported to be ordinarily crepuscular, attacking readily on cloudy days and in the evening (Curtis, 1953; Harmston & Lawson, 1967). However, Gjullin *et al.*, (1961) reported that they were active and bit readily even in bright sunlight when the temperature was above 80 degrees F. Other than livestock (Twinn, 1931) and humans, the hosts of this species are unknown.

DISTRIBUTION

Aedes implicatus occurs in forested areas of northern United States south to Utah, Colorado, Idaho and Nebraska and is common in northern Canada and Alaska. (Gjullin *et al.*, 1961). It is rare in the southern part of its range, occurring mostly at higher altitudes (Harmston & Lawson, 1967; Gjullin & Eddy, 1972). *Aedes implicatus* is rare in New York, but it has been reported from Plattsburgh, Clinton County (Dyar, 1922); Elizabethtown, Essex County (Matheson, 1926); Cayuga Lake, Schuyler County (Barnes *et al.*, 1950) and "central New York" (Matheson, 1944).

IMPORTANCE

Aedes implicatus is of no known medical importance.

Aedes (Ochlerotatus) intrudens Dyar

Aedes intrudens Dyar, 1919. Insec. Inscit. menstr. 7:23. Type loc.: White River, Ontario, Canada.
Aedes impiger, of Felt, not Walker, 1904. Bull. N.Y. State Mus. 79:316. *New synonymy.*

DIAGNOSIS

FEMALE—HEAD: Proboscis dark-scaled; palpi dark with few, scattered, grayish scales; occiput with narrow pale-golden to yellowish-white scales dorsally, broad appressed yellowish scales laterally; torus yellow to brown, sometimes with a few white scales on inner surface. **THORAX:** Scutum integument black, usually uniformly clothed with golden-brown to brownish-yellow scales, sometimes with faint median stripe or pair of stripes of dark-brown scales; pleura with dense patches of grayish-white scales, presenting rough appearance, extending on sternopleuron one-half to two-thirds to propleuron, narrowly separate from prealar patch, not reaching lower margin of mesepimeron; postcoxal area bare; hypostigial area with or without scales; metameron with few pale scales; lower mesepimeral bristles one to five, sometimes lacking. **ABDOMEN:** Tergites black-scaled with broad basal white bands, widened laterally; sternites pale-scaled. **LEGS:** Tarsi dark-scaled, unbanded. **WINGS:** Scales narrow, dark brown, usually with small patch of pale scales at base of costa.

MALE TERMINALIA—Lobes of ninth tergite short, rounded, each with five to eight short spines. **Tenth sternite** heavily sclerotized and hooked apically. **Phallosome** stout, constricted apically, open ventrally and along median dorsal line. **Claspette stem** pilose on basal half; with sharp, seta-bearing projection on mesal surface near middle; **filament** with sharp angular projection near middle. **Basistyle** 3½ to 4 times as long as width at middle with dense tuft of long setae on ventral surface near apex; **basal lobe** prominent, elongate, with long dorsal spine at base, two stout spines apically; **apical lobe** rounded, with few long setae. **Dististyle** short, expanded medially, with few short subapical setae; claw slender.

FOURTH INSTAR LARVA—HEAD: Antenna about three-fourths as long as head, darker on distal half; head hairs 5 and 6 with two to five branches. **THORAX:** Prothoracic hair 1 long, single; 2 short, single; 3 short, 2- to 4-branched. **ABDOMEN:** Comb with 8 to 20 scales, usually 12 to 16, in irregular patch, each scale thorn-shaped with minute lateral spinules at base. **SIPHON:** Siphon index about 3.0; pecten usually extending beyond middle of siphon, with distal 1 to 3 teeth detached; siphonal tuft inserted close to pecten, sometimes before apical tooth; dorsal preapical spine much shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete, ventral margin deeply incised; lateral hair single, much shorter than saddle; gills usually longer than saddle, pointed.

BIONOMICS

Aedes intrudens has a typical Northern *Aedes* type of life cycle, with one generation a year and overwintering in the egg stage. Eggs hatch somewhat later than those of *Aedes excrucians,* with first instar larvae appearing in about mid-April and fourth instar larvae present by early May. Third and fourth instar larvae have also been collected as late as mid-July in Albany County in depressions which became filled with rainwater to higher levels than they had earlier in the season.

In New York, larvae are usually found in temporary woodland pools, and most often in shallow snowmelt pools having a dense floor of rotten leaves, usually in pine or mixed pine/beech forests (Matheson, 1944) (fig. 21). They are also found in open bogs, pools in pastures and grassy drainage ditches, especially adjacent to pine forests. In Colorado, larvae occur primarily in deep, permanent pools in marshy meadows (Harmston & Lawson, 1967). They have occasionally been collected from shallow edges of semipermanent ponds in Suffolk County on Long Island, the type of habitat described for this species in Alaska (Jenkins, 1948). Larvae often graze along the bottom of a pool and may remain beneath leaves and other debris for long periods. For this reason, they are sometimes more efficiently collected by plunging the dipper into the bottom debris rather than skimming the surface.

Other species with which *intrudens* are commonly associated in New York include *Aedes excrucians*, *A. canadensis*, *A. communis*, *A. punctor* and *A. fitchii*. The author has also collected them with larvae of *Culex territans* and *C. restuans* in Suffolk County although *intrudens* were rare. Owen (1937) also found them associated with *Aedes diantaeus*, *A. flavescens* and *A. cinereus* in Minnesota.

Adults emerge beginning about mid-May and are present through August (Steward & McWade, 1961) or early September (Matheson, 1944). The author has collected females biting as early as May 20 and as late as August 30 in the Adirondacks and Albany County. The females are persistent biters anytime during the day or night (Steward & McWade, 1961; Natvig, 1948). They have been observed by the author and others (Dyar, 1919; Natvig, 1948; Owen, 1937) entering dwellings and biting readily.

DISTRIBUTION

Aedes intrudens is distributed throughout the northern United States, the Mountain States south into Utah and Colorado, southern Canada north to Alaska, and southern Europe. In New York, it is most common and abundant in the northeastern counties, but less abundant in the midwestern and southern regions.

IMPORTANCE

This species has not been incriminated in disease transmission, but it is an annoying, persistent biter during the day and night. It has been reported to travel long distances in search of food (Rempel, 1953). Since *intrudens* often constitutes a nighttime annoyance in houses, and is rather long-lived, it should be considered an important pest in some regions of the State.

Aedes (Ochlerotatus) mitchellae (Dyar)

Culex mitchellae Dyar, 1905. Jour. N.Y. Entomol. Soc. 13:74. Type loc.: Jacksonville, Florida.

DIAGNOSIS

FEMALE—HEAD: Proboscis dark-scaled with broad, median ring of pale scales; palpi dark with scattered, pale scales dorsally and apically; occiput with narrow, pale-yellow to golden scales medially, submedian patches of reddish-brown to bronze-brown scales and with broad, appressed, white scales and dark patches laterally; torus dark brown with pale scales on inner surface. **THORAX:** Scutum integument black; clothed with narrow, pale, golden-brown scales, darker laterally, often with faint, narrow submedian lines of pale-golden to silvery scales; prescutellar space with pale-golden scales and brown setae; pleura with rather sparse patches of grayish-white scales, extending on sternopleuron to propleuron, on mesepimeron halfway to lower margin; postcoxal area, metameron and hypostigial area without scales; lower mesepimeral bristles none to 2, usually one. **ABDOMEN:** Tergites dark-scaled with narrow, basal bands and large median patches of white to yellowish-white scales, sometimes joined to form continuous longitudinal stripe; sternites mostly pale-scaled. **LEGS:** Most tarsal segments with broad, basal, white bands, segments 4 and 5 of fore- and mid-tarsi entirely dark, segment 5 of hind tarsi entirely white. **WINGS:** Scales narrow, dark.

MALE TERMINALIA—Lobes of ninth tergite much wider than long, each with four to seven stout spines. **Tenth sternite** heavily sclerotized on apical half. **Phallosome** conical, stout, rounded apically. **Claspette stem** stout, pilose, with short subapical seta; **filament** about as long as stem, slender. **Basistyle** about 3 times as long as wide; **basal lobe** prominent, rounded, with many slender setae apically; apical lobe absent. **Dististyle** long, pilose, wider on basal half.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head; head hairs 5 and 6 usually single (5 occasionally double). **THORAX:** Prothoracic hair 1 long, single; 2 short, single; 3 short, single or double. **ABDOMEN:** Comb with 10 to 20 scales, or 13 to 16 in patch, each scale thornlike with a strong median spine and very short lateral spinules at base. **SIPHON:** Siphon index 3.0 to 3.5; pecten teeth evenly spaced, not reaching middle of siphon, dorsal preapical spine as long as apical pecten tooth. **ANAL SEGMENT:** Saddle complete; lateral hair single, almost as long as saddle; gills variable, dorsal pair usually about 1½ times as long as saddle, longer than ventral pair, pointed.

Carpenter and LaCasse (1955) state that the larvae are found in temporary freshwater pools in the coastal plains. *A. mitchellae* is found primarily in southern United States, reaching its greatest abundance in the Atlantic and Gulf states where larvae and adults are present throughout the year. In New York, it has been reported only from Staten Island, Richmond County (Barnes *et al.*, 1950). The females are reported to be fierce biters (King *et al.*, 1939). Eastern Encephalitis virus has been isolated from *mitchellae* in Georgia (Karstad *et al.*, 1957), but because of its rarity it is of no economic importance in New York.

Aedes (Ocherotatus) punctor (Kirby)

Culex punctor Kirby, 1837. *In* Richardson's Fauna Bor. Amer. 4:309. Type loc.: Northwest Territory, Canada.

Culex implacabilis Walker, 1848. List. Dipt. Brit. Mus. 1:7. Type loc.: Ontario, Canada.

Culex provocans Walker, 1848. List Dipt. Brit. Mus. 1:7. Type loc.: Nova Scotia.

Culex fusculus Zetterstedt, 1850. Dipt. Scand. 9:3459. Type loc.: Sweden and Norway.

Culicelsa auroides Felt, 1905. Bull. N.Y. State Mus. 97:449. Type loc.: Elizabethtown, New York.

For complete synonymy and additional references, see Monchadskii (1951:196), Carpenter & LaCasse (1955:217), Natvig (1948:33), Knight (1951:90), Vockeroth (1954a:248), Stone *et al.* (1959:151).

Knight (1951) described two varieties, "*punctor*" variety and "tundra" variety of *punctor*, based on color and markings. The author has collected only what appear to be "*punctor*" variety in New York although there is considerable variation among the specimens examined.

Larvae of *punctor* normally have 10 or more comb scales. The author has occasionally collected fourth instar larvae with as few as five scales, making it appear more like *hexodontus*. Larvae of these species can be distinguished by the key characters; *i.e.*, comb scales of *punctor* are less than 1 mm, the terminal spine about 1.5 times as long as base (Vockeroth, 1954a; M. Smith, Univ. of Massachusetts, Amherst, Mass., pers. comm., 1973).

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled, occiput with narrow, pale-yellow to golden scales dorsally, broad cream-colored scales laterally; torus light brown, darker and occasionally with few pale scales on inner surface. **THORAX:** Scutum integument dark brown, usually with median stripe or pair of stripes and sometimes posterior half-stripes of coppery- to dark-brown scales; yellowish to reddish scales laterally; prescutellar space with pale-yellowish scales; pleura with extensive patches of grayish-white scales, extending on sternopleuron to propleuron and on mesepimeron to lower margin; postcoxal area and metameron with pale scales; hypostigial area bare; lower mesepimeral bristles one to five. **ABDOMEN:** Tergites dark-scaled with basal, white bands; sternites pale-scaled, some segments usually with few black scales apically. **LEGS:** Tarsi dark-scaled, unbanded. **WINGS:** Scales narrow, dark brown; costa frequently with few pale scales at base.

MALE TERMINALIA—Lobes of ninth tergite sclerotized, slightly longer than wide, each with several strong spines. **Tenth sternite** heavily sclerotized apically. **Phallosome** cylindrical, notched apically. **Claspette stem** short, stout, curved, pilose on basal half; **filament** shorter than stem, broadened near middle, tapered apically to a recurved point. **Basistyle** about 3½ times as long as wide; **basal lobe** large, triangular-shaped, clothed with numerous short setae, with a basal row of long setae, and strong dorsal spine; dorsobasal protuberance small (prominent on *abserratus*); **apical lobe** broadly rounded, with many small, flattened, curved setae. **Dististyle** two-thirds as long as basistyle, slightly widened medially, pilose, with few subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head; head hairs 5 and 6 single or double (occasionally triple). **THORAX:** Prothoracic hairs 1, 2 and 3 long, subequal, usually all single (1 and 3 occasionally double). **ABDOMEN:** Abdominal hair 1 on segments IV and V single, erect, nearly as long as hair 6; hair 6 single; comb scales 10 to 15 (occasionally as few as 5 or as many as 21), in irregular single or double row, each scale almost as long as outer pecten tooth, thornlike with strong median spine and small lateral spinules. **SIPHON:** Siphon index about 3.0; pecten teeth evenly spaced; dorsal preapical spine shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle complete; lateral hair single, as long as or slightly longer than saddle; gills usually 1½ to 3 times as long as saddle, pointed.

BIONOMICS

Aedes punctor is a univoltine species having a typical Northern *Aedes* type of life cycle. Eggs are deposited singly on moist earth or leaves lining depressions which become filled with water in the spring, primarily in or near heavily wooded areas at higher elevations. Eggs begin to hatch early in the spring, after those of *intrudens* and before *canadensis* and *cinereus*, in early April in the Adirondacks and Helderbergs. Fourth instar larvae are often collected as early as mid-April, especially in shallow, open pools. They are most abundant during May and are occasionally still found until July in cold, heavily shaded areas.

Larvae occur most often in cool temporary pools in heavily wooded habitats, especially in acidic water in sphagnum bogs in coniferous or mixed forests. Whether the species prefers acidic water or whether larvae occur in this water because of availability in its habitat has not been established. Larvae are also frequently found in wheel ruts in roadways adjacent to wooded habitats. Twinn *et al.* (1948) found them in Manitoba primarily in grass-bottomed, snowmelt pools in the open. Steward and McWade (1961) reported that they occur in Ontario in open roadside ditches and marshes as well as in shaded woods. Frohne (1953) found *punctor* breeding in brackish water in Alaska, but the author has not found them in saline habitats in New York.

The aquatic stages usually complete development in 2 to 3 weeks, but may require up to 6 weeks in especially cold habitats. Larvae have been observed to survive alternate freezing and thawing and may be frozen solidly in ice without impairing development (Callot & van Ty, 1944; Jachowski & Schultz, 1948; MacGregor, 1925). When the developmental period is long, the individuals usually become quite large and larvae vary considerably in size depending upon the length of development. The most common associates of *punctor* larvae in New York are *Aedes abserratus*, *A. canadensis*, *A. cinereus*, *A. excrucians*, *A. fitchii*, *A. stimulans* and *A. trichurus*. Other species are *A. intrudens*, *A. communis* and *Culiseta morsitans dyari*.

Adult emergence begins in about the third week of April and continues through May and early June, with the majority of individuals emerging about mid-May. Steward and McWade (1961) reported that the females persist all summer and can be taken biting as late as September in Ontario. The author has found them annoying in New York until early August, especially in cool, wooded areas at higher elevations. Female *punctor* are persistent biters which attack during the day and after dark. Jenkins (1948) reported they were most active in Alaska in late afternoon. In the Adirondacks, they are generally crepuscular, with their greatest activity in the early morning, at dusk and for 2 to 3 hours after dark. Most biting occurs in woods and adjacent clearings, although it is not uncommon for *punctor* to enter dwellings to feed after dark.

Hosts, in addition to man, include large and small mammals. Birds and coldblooded animals have not been found to serve as hosts for *punctor* in North America. However, Natvig (1948) observed nestlings of buzzards and hawks being attacked by this species in Norway. Hosts in North America include beef, horse, pig, dog, rodent (Downe, 1960—precipitin tests); Whitetail Deer, Raccoon, Opossum, Domestic Rabbit, Woodchuck, Gray Squirrel (Wright & DeFoliart, 1970).

DISTRIBUTION

Aedes punctor is Holarctic in distribution; its ranges includes northern Asia and Europe, North America extending from northern Canada and Alaska south to New York, Michigan, Minnesota, Idaho, Washington and in the Mountain States south to Colorado. In New York, this species is common and abundant in the north and at high elevations such as the Adirondacks, Catskills, Allegheny Plateau and Helderbergs. It also occurs at lower altitudes, but is rarely abundant.

IMPORTANCE

With the exception of two isolations of California Encephalitis virus from pools of *Aedes punctor* in Alaska (Sudia *et al.*, 1971), this species has not been incriminated in disease transmission. However, it is considered the major pest species in parts of Ontario. In New York, it may be a major pest, especially in late spring and early summer and in some of the more dense areas, until early fall.

Aedes (Ochlerotatus) riparius Dyar & Knab

Aedes riparius Dyar & Knab, 1907. Jour. N.Y. Entomol. Soc. 15:213. Type loc.: Manitoba, Canada.

Aedes semicantans Martini, 1920. S. B. naturf. Ges. Rostock 7:205. Type loc.: Europe.

DIAGNOSIS

FEMALE—HEAD: Proboscis with light-brown scales intermixed with dark scales, light scales numerous toward middle; palpi dark-scaled with pale (yellowish-white) scales at apices of most segments; occiput with narrow, yellowish scales medially, brown submedian patches and broad, appressed, cream-white scales with black patches laterally; torus light to dark brown with few pale scales on inner surface. **THORAX:** Scutum integument dark brown with yellowish-white scales laterally and in the prescutellar space; with a broad median stripe and usually posterior half-stripes of golden to light-brown scales; pleura with sparse, extensive, white-scale patches, extending on sternopleuron to propleural patch and on mesepimeron more than halfway to lower margin; postcoxal area, hypostigial area and metameron with pale scales; lower mesepimeral bristles absent. **ABDOMEN:** Tergites with brown and yellowish-white scales intermixed and with pale, basal bands; sternites with yellowish-white and brown to black scales intermixed and with pale, basal bands. **LEGS:** Tarsal segments, except segments 1 on all legs and 5 on front and middle legs, with broad, basal, white bands. **WINGS:** Scales narrow, mostly dark with white scales intermixed.

MALE TERMINALIA—Lobes of ninth tergite short, about as long as broad, each with several long spines. **Tenth sternite** sclerotized and hooked apically. **Phallosome** cylindrical, narrowed and notched apically. **Claspette** stem slender, pilose; **filament** nearly as long as stem, broadly expanded near base, bladelike, tapered to recurved point apically. **Basistyle** about 2½ to 3 times as long as wide; with many short setae and scales, but few long setae; **basal lobe** prominent, conical, with many short setae, basal row of long setae and long, stout seta dorsobasally; **apical lobe** prominent, broadly rounded, with many short, flat setae. **Dististyle** about half as long as basistyle, slightly widened medially, pilose, with few subapical setae; claw slender.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head; head hairs 5 and 6 usually double. **THORAX:** Prothoracic hair 1 long, usually single; 2 short, single; 3 short, usually double or triple. **ABDOMEN:** Comb scales usually 6 to 10 in an irregular row, each scale thornlike with strong, median spine and short, lateral spinules at base. **SIPHON:** Siphon index 3.0 to 3.5; pecten teeth extending beyond middle of siphon, outer two to three teeth detached; dorsal preapical spine shorter than apical pecten teeth. **ANAL SEGMENT:** Saddle incomplete; lateral hair single, shorter than saddle; gills about 1 to 1½ times as long as saddle, pointed.

BIONOMICS

Aedes riparius exhibits the Northern *Aedes* type of life cycle with overwintering eggs producing a single generation. Larvae are found in small early spring pools and especially in weedy ditches on the prairie or in the transition zone between the forest and prairie (Rempel, 1953).

In Saskatchewan, adults emerge from middle to late May. Females bite during day or night, usually in open country and in lightly shaded forests (Carpenter & LaCasse, 1955; Dyar, 1923). According to Dyar (1923), the females are not aggressive biters. Little information has been reported about the bionomics of *riparius.*

DISTRIBUTION

Aedes riparius occurs in the plains of north and central United States, western Canada north to Alaska and northern Europe (Carpenter & LaCasse, 1955; Rempel, 1953; Knight & Wonio, 1969; Steward & McWade, 1961). The *A. riparius* reported from Colorado by Dyar (1924b) has been found to be *A. excrucians* (Harmston & Lawson, 1967). It has been reported from New York only once, from Onondaga County near Syracuse (Matheson, 1944). Dyar reported that it does not normally occur in the Atlantic region due to the dense eastern forests.

IMPORTANCE

Since this species is rare in New York State, it is of no importance here.

Aedes (Ochlerotatus) sollicitans (Walker)

Culex sollicitans Walker, 1856. Ins. Saund. Dipt.: 427. Type loc.: United States.

DIAGNOSIS

FEMALE—HEAD: Proboscis dark-scaled, with broad, white band near middle, palpi dark-scaled, few white scales at apex; occiput with narrow, golden-yellow scales and submedium patches of bronze-brown scales dorsally; broad, appressed, yellowish scales and dark patches laterally; torus brown with pale scales on inner and dorsal surfaces. **THORAX:** Scutum integument black, clothed with golden-brown scales, dark laterally, occasionally with pale-yellow to golden-yellow submedian lines; prescutellar space usually with pale-golden to white scales; pleura with dense patches of grayish-white, appressed scales extending on sternopleuron to propleuron and on mesepimeron halfway to lower margin; metameron without scales; postcoxal area and hypostigial area with few to many pale scales. **ABDOMEN:** Tergites white-scaled laterally, with pale-yellow scales basally and medially, usually forming longitudinal stripe; sternites pale-scaled with few dark scales intermixed. **LEGS:** Most tarsal segments with broad basal white bands, hind basitarsus also with pale-yellow median ring; segment 4 of front and midtarsi unbanded, apical segment unbanded, varying from all dark to all white.

MALE TERMINALIA—Lobes of ninth tergite short, much wider than long, heavily sclerotized apically, each with four to seven short spines. **Tenth sternite** heavily sclerotized on distal half. **Phallosome** conical, stout, rounded apically. **Claspette stem** short, stout, pilose, with short subapical seta; **filament** as long as stem, slender. **Basistyle** about 3 times as long as wide; **basal lobe** a slightly raised expansion, bearing several setae; **apical lobe** absent. **Dististyle** about two-thirds as long as basistyle, slightly broader on basal third, pilose.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head; head hairs 5 and 6 long, usually single. **THORAX:** Prothoracic hair 1 long, single; 2 medium, single; 3 short, usually single or double. **ABDOMEN:** Comb scales in patch of 10 to 20, each scale thornlike with a strong medium spine and small lateral spinules. **SIPHON:** Siphon index 2.0 to 2.5; pecten teeth evenly spaced (occasionally with apical tooth detached), extending to or slightly beyond middle of siphon; dorsal preapical spine as long as apical pecten tooth. **ANAL SEGMENT:** Saddle complete; lateral hair shorter than saddle; gills usually short, budlike, occasionally as long as saddle or longer, bluntly rounded.

BIONOMICS

Aedes sollicitans, the "white banded salt marsh mosquito" or "New Jersey" mosquito, is a multivoltine species. It occurs in saline water, primarily in coastal salt marsh areas, and in temporary pools inland. Eggs are deposited singly on mud on the lower regions of salt marsh or other places where they will be inundated by saline water. Smith (1904a) found that a female laid up to 200 eggs in a single batch, but that only one batch was deposited by an individual. The eggs must be dried for at least 24 hours after being laid. They remain viable for several months. After being inundated, all of the eggs may hatch within a few minutes or partial hatching may occur with about 50 percent remaining unhatched until a second or third flooding. At least some of the unhatched eggs overwinter to produce the first generation the following spring. Overwintering eggs hatch in New Jersey and on Long Island in April, and adults are on the wing by mid-May. Successive generations produce adults until late September or October, and larvae and adults have been collected as late as mid-November.

Larvae occur most abundantly in saltwater (10–15 percent salinity). They can sometimes be collected at the lower end of a salt marsh in areas of highest salinity "by the millions." They also occur in brackish water (6–8 percent salinity) and in fresh water, often in large numbers (Richards, 1938; Ostergaard *et al.*, 1961) (fig. 28).

Female *sollicitans* normally feed at night and rest in vegetation during the day, however they attack readily even in full sunlight if their resting places are disturbed. Smith (1904) states, ". . . at the slightest disturbance, they investigate and in a moment a cloud surrounds the disturber." According to Smith (op. cit.) there are many records of persons being driven almost frantic by the swarms of biting *sollicitans* and unsubstantiated stories of individuals being rendered unconscious or delirious by them. He further states, "I have seen little ones with their legs covered with bites, swollen and sometimes bleeding; really ill and crying from pain." At times when the wind is blowing hard enough to discourage mosquitoes from flying, they crawl up the legs of anyone walking in their resting places. At night they sometimes fly long distances from the marsh to feed and have been collected as far as 100 miles from the nearest known breeding place (Carpenter & Middlekauf, 1944). Although they are persistent outdoor biters, they usually do not attempt to enter houses.

Thompson *et al.* (1963) reported that horses, and occasionally other large mammals were the preferred hosts for *sollicitans*. Jobbins *et al.* (1961) and Crans (1962) found that deer and other large mammals were preferred when such animals were available. However, Murphy *et al.* (1967) found that *sollicitans* would also attack and feed readily on a wide variety of warm-blooded animals and were somewhat attracted to cold-blooded animals. Host records include the following animals: **MAMMALS:** Woodchuck, Muskrat, Raccoon, Opossum, Red Fox, Meadow Vole, River Otter, Guinea Pig; **BIRDS:** Mallard, Canada Goose, Common Egret, Barn Owl, Red-winged Blackbird, Turkey Vulture, Chicken; **REPTILE:** Kingsnake; **AMPHIBIAN:** Snapping Turtle.

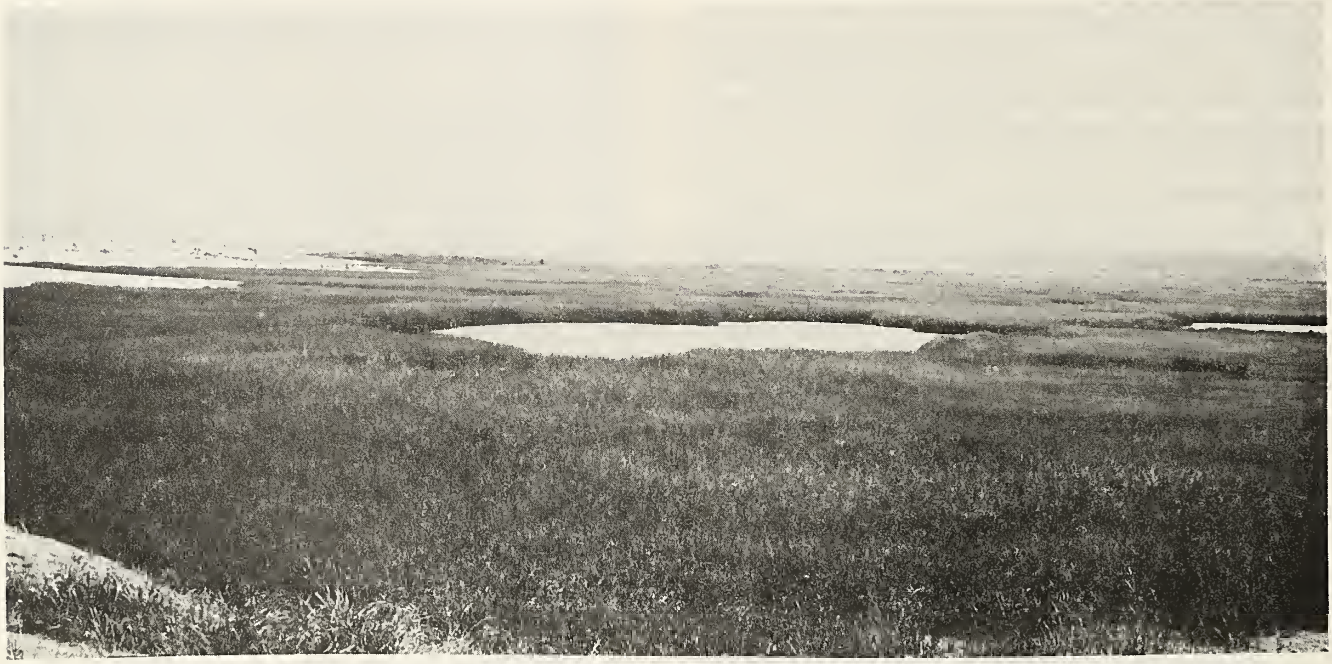

Figure 28. Habitat of white-banded salt marsh mosquito, *Aedes sollicitans*

DISTRIBUTION

Aedes sollicitans occurs in the Nearctic region in saline water on the gulf and Atlantic coast from Texas to New Brunswick and inland where saline water exists. For a more detailed list of the inland distribution, see Carpenter & LaCasse (1955). In New York, *sollicitans* occurs primarily in the coastal regions and is abundant in the salt marshes of Richmond and Suffolk Counties. The species has also been collected in saline pools in Onondaga County near Syracuse and Genesee County near Batavia and in brackish pools along the New York Thruway and other highways from New York City to Buffalo. It is possible, as mentioned in the discussions of *Aedes dorsalis* and *Aedes cantator*, that the water in these roadside pools has been made brackish by the use of large amounts of salt to clear the road of ice during the winter.

IMPORTANCE

The viruses of Eastern, St. Louis and California Encephalitis have been isolated from wild populations of *Aedes sollicitans* (Kandle, 1961, 1967; Goldfield *et al.*, 1968; Sudia *et al.*, 1971). In addition, *sollicitans* has been incriminated as a vector of canine filariasis (Beam, 1965). This species is one of the most important species in the coastal regions of New York, as a potential vector and as a pest species requiring constant surveillance and control measures.

Aedes (Ochlerotatus) spencerii (Theobald)

Culex spencerii Theobald, 1901. Monogr. Cul. 2:99. Type loc.: Stony Mt. and St. Boniface, Manitoba, Canada.

DIAGNOSIS

FEMALE—HEAD: Proboscis dark-scaled; palpi dark with scattered white scales; occiput with narrow, yellowish scales dorsally; dark patches surrounded by grayish-white, broad, appressed scales laterally; torus black with grayish-white scales on inner and dorsal surfaces. **THORAX:** Scutum integument black, with yellowish-white scales dorsolaterally, and broad median stripe or pair of stripes and usually posterior half-stripes of coppery- to golden-brown scales; pleura with extensive patches of grayish-white scales, extending on sternopleuron to propleuron and on mesepimeron more than halfway to lower margin; postcoxal area and metameron with pale scales, hypostigial area with or without scales. **ABDOMEN:** Tergites either entirely white-scaled or with basal and apical bands and median stripe, remaining area dark-scaled; sternites pale-scaled. **LEGS:** Tarsal segments unbanded, mostly dark-scaled with some white scales intermixed, especially on posterior surfaces. **WINGS:** Scales narrow; costa and veins 1, 3 and 5 dark-scaled, others pale-scaled.

MALE TERMINALIA—Lobes of ninth tergite slightly broader than long, heavily sclerotized, each with several stout spines. **Tenth sternite** heavily sclerotized and hooked apically. **Phallosome** cylindrical, rounded and notched apically. **Claspette stem** slender, pilose, with two or three subapical setae; **filament** shorter than stem, roundly expanded from near base, bladelike, tapered to recurved tip, with small notch on outer edge near base. **Basistyle** 3 to 3½ times as long as wide; **basal lobe** a large, pronounced constriction at base, with numerous setae and a large apically hooked dorsal spine; **apical lobe** broadly rounded with few short retrorse setae. **Dististyle** two-thirds as long as basistyle, slightly expanded medially, pilose, with few short subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna about one-third as long as head; head hairs 5 and 6 single (ocassionally one hair double). **THORAX:** Thorax spiculate; prothoracic hair 1 medium, single; 2 short, single; 3 short, single or double. **ABDOMEN:** Abdomen spiculate; comb scales 6 to 13 arranged in irregular row, each scale with long, tapered central spine and minute spinules on basal part. **SIPHON:** Siphon index 2.0 to 2.5; pecten teeth usually extending to beyond middle of siphon with outer 1 to 3 teeth detached; dorsal preapical spine shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete, almost meeting ventrally; lateral hair single, much shorter than saddle; gills 2 to 3 times as long as saddle, pointed.

BIONOMICS

Aedes s. spencerii occurs almost entirely in the prairie regions of northern United States and southern Canada. Larvae breed in cold water of shallow, prairie pools, weedy roadside ditches, sphagnum mats and snowpools (Horsfall, 1955; Rempel, 1953). This is the earliest, most abundant and most widespread species occurring on Saskatchewan prairies, with larvae common during late April and adults flying by early May (Rempel, 1953). Other species with which larvae of *spencerii* have been reported include *A. canadensis* (Owen, 1937) and *A. fitchii* (Hearle, 1932). In Saskatchewan, *spencerii* normally has at least two generations a year and often a third if rainfall is sufficient in early fall (Rempel, 1953.)

Females are said to be fierce biters which attack readily during the day and evening. They bite in shade or bright light, but have been observed to feed only in the open, dissipating when a host enters wooded areas (Knab, 1908). Knab (1908) also observed females to rise out of the grass on the leeward side of a host, fly against the wind and attack with great force. *Spencerii* apparently feeds on any available warmblooded animal. Rempel *et al.* (1946) collected females which had engorged on human, beef, horse and bird bloods, as determined by precipitin reactions with antisera for these hosts. *A. spencerii* has been observed to fly as far as 3 miles in search of blood (Rempel, 1953).

DISTRIBUTION

Aedes s. spencerii is a common pest species in the plains of the northern United States and Canada. There it is the dominant species in spring and early summer from Minnesota west to Montana, north into Canada as far as Waskesiu, Saskatchewan (Rempel, 1953; Matheson, 1944). In the Pacific Northwest, it is replaced by *A. s. idahoensis* (Gjullin & Eddy, 1972). It has been collected occasionally in Illinois and Michigan (Matheson, 1944). A single female was collected in a biting collection in Lake Placid (Essex County), New York (Barnes *et al.*, 1950) and 12 females (unconfirmed identifications) were collected in a light trap in Erie County (E. Bosler, N.Y. State Health Department, Albany, N.Y.; pers. comm., 1974).

IMPORTANCE

Aedes spencerii is rare and of no known importance in New York.

Aedes (Ochlerotatus) sticticus (Meigen)

Culex sticticus Meigen, 1838. Syst. Beschr. zweifl. Ins. 7:1. Type loc.: Bavaria, Germany.

Culex nigripes var. *sylvae* Theobald, 1901. Monogr. Cul. 2:96. Type loc.: England.

Culex hirsuteron Theobald, 1901. Monogr. Cul. 2:98. Type loc.: Woodstock, Virginia.

Culex aestivalis Dyar, 1904. Jour. N.Y. Entomol. Soc. 12:245. Type loc.: British Columbia, Canada.

Culex pretans Grossbeck, 1904. Entomol. News 15:332. Type loc.: Great Piece Meadow, New Jersey.

Aedes aldrichi Dyar & Knab, 1908. Proc. U.S. Nat. Mus. 35:57. Type loc.: Market Lake, Idaho.

Aedes lateralis (Meigen), of Edwards, 1932. Genera Insectorum: 144.

For complete synonymy and additional references, see Stone *et al.*, (1959:154).

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with narrow, yellow scales dorsally; broad, appressed yellow scales with dark patches laterally; torus yellow to brownish yellow with grayish-white scales on inner surface. **THORAX:** Scutum integument dark brown to black with median stripe or pair of stripes and posterior half-stripes of dark-brown scales, fine, yellowish-white scales laterally and in prescutellar space; pleura with well-defined, grayish-white scale patches extending on sternopleuron in narrow line to propleuron and on mesepimeron more than halfway to lower margin; postcoxal area and hypostigial area without scales; metameron with a few pale scales; lower mesepimeral bristles absent. **ABDOMEN:** Tergites dark-scaled with narrow, basal, white bands and basolateral triangular patches; sternites white-scaled, apices usually with few dark scales intermixed. **LEGS:** Tarsi unbanded, dark-scaled except for few scattered white scales sometimes present. **WINGS:** Scales narrow, dark except for few white scales usually present at base of costa and subcosta.

MALE TERMINALIA—Lobes of ninth tergite about as long as broad, each bearing three to seven stout spines. **Tenth sternite** heavily sclerotized distally. **Phallosome** conical, rounded apically, twice as long as broad. **Claspette stem** stout, pilose, with one to three small subapical setae; **filament** about one-third as long as stem, broadly expanded near base, bladelike, tapered and curved apically. **Basistyle** about 3 times as long as wide; **basal lobe** prominent, quadrate, bearing many short setae apically, dense tuft of long setae and long recurved dorsal spine basally; **apical lobe** broadly rounded, with short retrorse setae. **Dististyle** expanded medially, pilose, with two or three subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head; head hairs 5 and 6 with two to five branches. **THORAX:** Prothoracic hair 1 long, single; 2 medium, single; 3 short, single or double; 5 long, single (double or triple on *dorsalis*). **ABDOMEN:** Comb scales in patch of 18 to 25, each thornlike with long, median spine and smaller lateral spinules.

SIPHON: Siphon index 2.5 to 3.0; pecten teeth evenly spaced; siphonal tuft less than three-fourths as long as width of siphon at point of insertion; dorsal preapical spine shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete, almost meeting ventrally; lateral hair single, shorter than saddle; gills longer than saddle, pointed.

BIONOMICS

A. sticticus is a univoltine species which may have two or more broods a year (Horsfall & Trpis, 1967). The larvae are found in temporary woodland pools in the floodplains of larger rivers, hence the term "floodwater mosquitoes." Eggs are laid singly in late June in a variety of moist places including soil and vegetation of gullies, potholes and swales, moss and rotten wood. In the floodplains of the lower Columbia River in Washington and Oregon, eggs are found at all levels flooded by the river between the 8- and 25-foot stages, but most often between 10- and 20-foot levels (Gjullin *et al.*, 1950; Horsfall & Trpis, 1967). Overwintering eggs begin hatching when the water in temporary woodland pools or floodwaters reaches about 15° C. (Horsfall & Trpis, 1967). A reduction in dissolved oxygen is said to be the most important hatching stimulus (Gjullin *et al.*, 1950; Gjullin *et al.*, 1939; Gjullin *et al.*, 1941). For this reason, hatching does not occur in highly oxygenated running water nor in areas which are quickly or deeply flooded. According to Gjullin *et al.* (1950), this necessity of reduced oxygen due to the presence of organic matter assures that there is an abundant food supply for newly hatched larvae.

In New York, eggs begin to hatch in early to mid-April but development of early hatching larvae is slow until the water warms to 70–90° F. (Gjullin *et al.*, 1950). Fourth instar larvae can be found in Suffolk County by early May and in the central counties by mid-May. Partial hatching is common, with one or more broods following the first brood in June, July or even August. This is because (1) eggs which were deposited above the level of the first flooding sometimes later become inundated with higher floodwaters (Horsfall & Trpis, 1967), (2) eggs which are submerged during the winter frequently do not hatch until the water has dissipated and they have been reflooded, (3) eggs which are flooded deeply sometimes do not hatch because the oxygen level is not reduced, but do hatch when the area is reflooded at a lower level, or (4) eggs which are buried more than an inch deep in the soil usually do not hatch until the soil is turned over or loosened, which might occur before a second flooding. Eggs of *sticticus* remain viable for up to 3 years (Gjullin & Yates, 1946). If floodwaters do not reach the eggs in one year, they may in another year, resulting in an unusually high population with more than one year's eggs hatching at one time.

The larvae of *sticticus* develop slowly in cold water, quite rapidly in warm water, requiring only 6 days for development through pupation at 80° F. in the laboratory and 10 days to 3 weeks in nature (Gjullin *et al.*, 1950).

Because of its long development period in the spring, the larvae of *sticticus* have been reported to be associated with a wide range of woodland pool species. The New York species with which it has been reported include *A. cinereus*, *A. canadensis*, *A. punctor*, *A. stimulans*, *A. excrucians*, *A. dorsalis* and *Culiseta morsitans* (Owens, 1937; Rees, 1943; Callot & van Ty, 1944; Séguy, 1923; Siverly, 1972). In the summer *sticticus* is most commonly found associated with *A. vexans*, *Culex restuans* and *C. pipiens*.

A. sticticus females have been reported to travel long distances, as far as 5 miles according to Stage *et al.* (1937) and 16 km between larval and feeding sites in western Canada (Hearle, 1932).

The females are persistent and aggressive biters. They attack readily during daylight hours in woods and protected places until dusk, but feed little after dark (Siverly, 1972; Gjullin *et al.*, 1950; Matheson, 1944). Rees (1943) and Hearle (1932) observed that *sticticus* females enter dwellings to feed. Gjullin (1947) found that black, blue and red surfaces (shirts) were equally attractive to *sticticus* females, but that tan, green and yellow were only about half as attractive.

In addition to feeding readily on humans, this species has been reported to be a general feeder. It prefers large woodland mammals, but, when abundant, it feeds on practically any available host except frogs. The following hosts have been recorded for *sticticus*: **MAMMALS:** pig, deer, beef, horse, Whitetail Deer, Raccoon, Red Fox, Opossum, Domestic Rabbit, Eastern Cottontail, Beaver, Woodchuck, Gray Squirrel, Fox Squirrel, Chipmunk, Ground Squirrel, White-footed Mouse; **BIRDS:** Chicken; **REPTILES:** Snapping Turtle, Blanding's Turtle, Painted Turtle, Fox Snake (Wright & DeFoliart, 1970; Downe, 1960).

DISTRIBUTION

A. sticticus is widely distributed throughout the Holarctic region, including the United States, Canada, Alaska, Europe and Siberia. (Stone *et al.*, 1959; Horsfall, 1955; Carpenter & LaCasse, 1955). It occurs throughout New York State at low elevations, especially in the plains of the large rivers, the Great Lakes and the Finger Lakes.

IMPORTANCE

This species is a nuisance and locally a major pest, especially following extraordinary flooding of rivers and streams. Numerous attempts have been made at isolating arboviruses from *sticticus* but so far it has not been incriminated in the transmission of these pathogens (Siverly, 1972; Stamm *et al.*, 1962; Sudia *et al.*, 1971). It has been reported as a potential vector of canine filariasis (Bemrick & Sandholm, 1966). However, Ludlam *et al.* (1970) were of the opinion that *sticticus* was not a good potential vector because it was univoltine and short-lived. Bishopp & Smith (1934) reported that females had been collected 46 days following their release, and Hearle (1932) reported flights of 16 km, thereby increasing its capability of obtaining and transmitting pathogens. Although there is no concrete evidence that *A. sticticus* is a vector of human or animal pathogens, it is an important pest species.

Aedes (Ochlerotatus) stimulans (Walker)

Culex stimulans Walker, 1848. List Dipt. Brit. Mus. 1:4. Type loc.: Nova Scotia, Canada.

Culicada subcantans Felt, 1905. Bull. N.Y. State Mus. 97:448, 474. Type loc.: New York.

Aedes stimulans classicus Dyar, 1920. Insec. Inscit. menstr. 8:113. Type loc.: Hudson County, New Jersey.

For complete synonymy, see Stone *et al.* (1959:155).

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark, with scattered white scales; occiput with narrow, pale-yellowish to yellowish-brown scales dorsally; submedian patches of narrow, golden-brown to brown scales; and broad, appressed, yellowish-white scales laterally; torus yellow to brownish-yellow, sometimes with few white scales on inner surface. **THORAX:** Scutum integument black, with variable pattern of brown and yellowish-white scales, usually with broad, median stripe and posterior half-stripes of brown scales, yellowish-white scales laterally; pleura with widely separated patches of white scales, extending on sternopleuron halfway to propleuron (sometimes with scattered scales extending further), widely separated from prealar patch; extending on mesepimeron about halfway to lower margin; postcoxal area and metameron with pale scales; hypostigial area bare; lower mesepimeral bristles well developed, usually three to four, occasionally fewer. **ABDOMEN:** Dark, with broad, basal bands of white to pale-yellow scales, frequently with scattered pale scales and with apices of terminal segments pale-scaled; sternites pale-scaled, usually with scattered dark scales. **LEGS:** Most tarsal segments with broad basal white bands; tarsal claws with primary tooth strongly curved, secondary tooth shorter than distance from its tip to tip of primary tooth (usually indistinguishable from *A. fitchii.* **WINGS:** Scales narrow, intermixed brown and white; pale scales usually few in number and located chiefly on anterior veins.

MALE TERMINALIA—Lobes of ninth tergite about as long as wide, each with several strong spines. **Tenth sternite** heavily sclerotized on apical third. **Phallosome** subcylindrical, narrowed and notched apically. **Claspette stem** slender, pilose on basal half; **filament** about as long as stem, with bladelike angular expansion near middle, tapered to recurved tip. **Basistyle** 3 to 3½ times as long as wide, with many long setae on inner ventral margin; **basal lobe** distinct, bluntly rounded, with many small setae apically and stout dorsal spine; **apical lobe** prominent, with few short setae. **Dististyle** about two-thirds as long as basistyle, slightly expanded medially.

FOURTH INSTAR LARVA—HEAD: Antenna less than half as long as head; head hair 5 with one to four branches (usually double), hair 6 single (occasionally double). **THORAX:** Prothoracic hair 1 medium, single; 2 short, single; 3 short, single or double. **ABDOMEN:** Comb scales in patch of 25 to 35, each scale much shorter than apical pecten tooth; with median spine and fringed with long subapical spinules about two-thirds as long as median spine. **SIPHON:** Siphon index 3.0 to 3.5; pecten teeth evenly spaced; dorsal preapical spine shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete, spiculate with strong spinules surpassing apical margin; lateral hair single (occasionally double), slightly shorter than saddle; gills usually somewhat longer than saddle, bluntly pointed.

BIONOMICS

A. stimulans has a typical Northern *Aedes* type of life cycle. It overwinters in the egg stage and has one generation a year (Matheson, 1944; Twinn, 1931; Owen, 1937). Although larvae are found in many types of wooded habitats, in New York, they usually occur in hardwood forest areas where maple and/or beech predominate. In the Adirondacks and Catskills, larvae are usually found in temporary or semipermanent, shal-

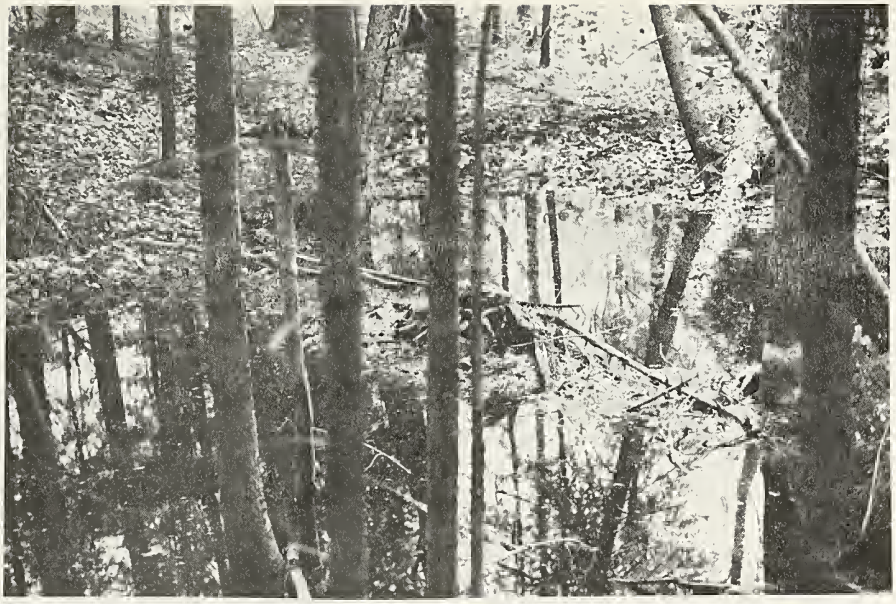

Figure 29. Typical woodland pool habitat for larvae of *Aedes stimulans* and other Northern *Aedes* mosquito species

low, woodland pools. They are frequently found in either floodpools from rivers or in drainage ditches in lowland areas. Breeding sites are usually partially shaded, and larvae tend to congregate in the shaded portion of the pool, following the shade around the pool as the position of the sunlight changes (fig. 29).

Eggs are laid toward the outer rim of a depression rather than the center of deeper portions (Siverly, 1972). Eggs hatch early, and first instar larvae can usually be found by mid-March to early April at the lower elevations in the valleys of the larger rivers. The author has collected second instar larvae in late February in the Hudson River Valley south of Albany. Larval development is slow, with adults usually appearing in early to mid-May in the southern part of the State and late May to early June in the northern counties and in the mountains.

The larvae usually develop at about the same rate, most of them emerging within a day or two of each other, frequently in great numbers. The author has collected as many as 200 larvae per dipper from a pool in Massena. Siverly (1972) reported that a single site in Indiana was estimated to produce 600,000 adult *stimulans*. Because they develop slowly and at about the same rate, large numbers of larvae are sometimes left stranded when the water evaporates before they have completely developed, especially in the mountains where larval development is slower than in the lowlands. However, fourth instar larvae or pupae stranded in this way sometimes complete develpment on mud alone and emerge as adults within a day or two.

Adult female *stimulans* usually remain close to their breeding site, but have been reported to range as far as three-quarters of a mile from the nearest production source in Indiana (Siverly, 1972). This species has frequently been found to be very abundant in woods on one side of a roadway and absent from woods on the other side. There is a single generation per year, and adults are most common in late spring and early summer, but commonly live until late summer or early fall, especially in deeper, cooler forested regions.

Female *stimulans* are general feeders, attacking a variety of warmblooded vertebrates, especially large mammals. Downe (1960) found this species had a preference for domestic animals and humans in farming areas. Wright & DeFoliart (1970) observed that coldblooded vertebrates are not utilized as hosts. Hosts which have been recorded include the following: **MAMMALS:** horse, pig, goat, rodent, beef, dog, Whitetail Deer, Raccoon, Red Fox, Opossum, Domestic Rabbit, Eastern Cottontail, Beaver, Woodchuck, Gray Squirrel, Fox Squirrel, Chipmunk, Ground Squirrel; **BIRDS:** "bird," Chicken, Woodcock (Downe, 1960; Wright & DeFoliart, 1960).

DISTRIBUTION

A. stimulans is distributed throughout most of Canada south of the tree line, Alaksa, the forested regions of northern United States south to California, Utah, Colorado, Missouri, Kansas and New Jersey.

Together with *Aedes fitchii*, *stimulans* is one of the most common species throughout New York State. The females of these two species are difficult to identify with certainty, and it is likely that some of the records for one species may refer to the other.

IMPORTANCE

A. stimulans is one of the most important pest species of man and domestic animals in the State, especially in forested areas in late spring and early summer. It is also frequently found biting late in the summer. California Encephalitis virus has been isolated from the species several times, thereby incriminating it as a potential vector (Sudia *et al.*, 1971; Sather, 1968). This species has also been incriminated as a potential vector of canine filariasis (Yen, 1938) and of the virus of Fowl Pox (Brody, 1936).

Aedes (Ochlerotatus) taeniorhynchus (Wiedemann)

Culex taeniorhynchus Wiedemann, 1821. Dipt. Exot. p. 43. Type loc.: Mexico.

Culex damnosus Say, 1823. Jour. Acad. Nat. Sci. Philadelphia 3:11. Type loc.: Pennsylvania.

Taeniorhynchus niger Giles, 1904. Jour. Trop. Med. 7:382. Type loc.: Antigua Island, (Lesser Antilles).

Culex portoricensis Ludlow, 1905. Can. Entomol. 37:386. Type loc.: San Juan, Puerto Rico.

Aedes epinolus Dyar & Knab, 1914. Insec. Inscit. menstr. Type loc.: Ventanillas, Peru.

DIAGNOSIS

FEMALE—HEAD: Proboscis dark-scaled with white ring near middle; palpi dark with white scales at tip; occiput with narrow, golden-yellow scales and submedian patches of narrow, dark scales dorsally; broad, appressed, white scales and dark patches laterally; torus brown with pale scales on inner surface. **THORAX:** Scutum integument dark brown, uniformly clothed with golden-brown scales except on anterior margin, above wingtips and in prescutellar space where scales are pale yellow to silvery white; pleura with small, widely separated patches of broad, grayish-white to silvery-white scales, extending on sternopleuron about halfway to propleuron (sometimes with scattered scales extending to the propleuron) and on mesepimeron about halfway to lower margin; postcoxal area, hypostigial area and metameron without scales; lower mesepimeral bristles 0 to 1. **ABDOMEN:** Tergites dark with basal bands and conspicuous lateral patches of silvery-white scales; sternites white-scaled basally, dark-scaled apically, sometimes with white scales intermixed. **LEGS:** Most tarsal segments with wide, basal, white bands and sometimes few white scales apically. **WINGS:** Scales narrow, dark.

MALE TERMINALIA—Lobes of ninth tergite about as long as broad, each with three to five stout setae. **Tenth sternite** heavily sclerotized on apical third. **Phallosome** cylindrical, rounded apically. **Claspette stem** slender, pilose, with short subapical setae; **filament** nearly as long as stem, with sharp retrorse projection near middle on convex side forming bladelike expansion tapering to a sharp point. **Basistyle** about 3½ times as long as wide; **basal lobe** prominent, broadly rounded, with many slender apical setae; apical lobe absent. **Dististyle** about half as long as basistyle, broadened medially.

FOURTH INSTAR LARVA—HEAD: Antenna less than half as long as head; head hairs 5 and 6 long, single. **THORAX:** Prothoracic hair 1 medium, single; 2 short, single; 3 short, usually double. **ABDOMEN:** Abdominal hair 6 with three to four branches on segments III to V (double on *sollicitans*); comb scales in patch of 10 to 20 (may be less than 10), each scale small, rounded and fringed with subequal spinules. **SIPHON:** Siphon index usually less than 2.0; pecten teeth evenly spaced extending to middle of siphon or slightly beyond; dorsal preapical spine as long as apical pecten tooth. **ANAL SEGMENT:** Saddle complete, spiculate with numerous spinules surpassing apical margin; lateral hair single, shorter than saddle; gills shorter than saddle, budlike.

BIONOMICS

The immature stages of *A. taeniorhynchus* are found primarily in high-tide salt marsh pools in coastal regions (Seaman, 1945), occasionally in freshwater pools near salt marshes and in brackish pools inland (Carpenter & LaCasse, 1955; Kumm *et al.*, 1940). This species is multivoltine and generations are continuous, at least in the warmer coastal marshes of the United States (Horsfall, 1955; Nielsen & Nielsen, 1953; Pratt, 1959). Eggs are laid on dry ground where they hatch when inundated by rain or tidewater (Nielsen & Nielsen, 1953). Larvae are almost always associated with larvae of *A. sollicitans*, *A. cantator* and *Culex salinarius* (Smith, 1904; Headlee, 1945; Richards, 1938). They have also been found associated with *A. vexans*, *A. canadensis*, *C. pipiens*, *C. territans*, *C. erraticus*, *Anopheles bradleyi* and *Psorophora confinnis* (Richards, 1938; Dorsey, 1944). Unlike larvae of most species which are usually more or less evenly distributed in a pool, the larvae of *taeniorhynchus* are usually congregated in dense clusters (Nielsen & Nielsen, 1953). Nielsen and Nielsen found that development from hatch to emergence took 9–15 days in Florida in February, April and late May.

The females are fierce, persistent biters, resting in vegetation close to their breeding areas and attacking anytime during the day in shaded places and at night, especially during the first hour of darkness (King *et al.*, 1939; Huffaker & Back, 1943). Like *A. sollicitans*, they usually prefer to bite the lower extremities near ground level (Headlee, 1945). They are thought to travel long distances, often creating a serious nuisance far from their breeding areas (Carpenter & LaCasse, 1955, Carpenter & Middlekauf, 1944).

DISTRIBUTION

A. taeniorhynchus is found along the Atlantic coast from Connecticut south to Brazil, the Pacific coast from southern California to Peru, and in Louisiana and Alabama. It reaches its greatest abundance in the coastal regions of the southern United States and in the Carribean (Carpenter & LaCasse, 1955; Matheson, 1944; Horsfall, 1955). It is rare in New York, which is at the northern limit of its range. The species was reported by Richards (1938) and by Barnes *et al.* (1950) from New York City and Long Island.

IMPORTANCE

Several strains of California Encephalitis virus have been isolated from *taeniorhynchus* in nature (Sudia *et al.*, 1971). It has been incriminated as a good potential vector of canine filariasis (Ludlam *et al.*, 1970). Since New York is north of its normal range, it is of little importance either as a pest species or as a vector of these pathogens.

Aedes (Ochlerotatus) thibaulti Dyar & Knab

Aedes thibaulti Dyar & Knab, 1910. Proc. Entomol. Soc. Wash. 11:174. Type loc.: Arkansas.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi black-scaled; occiput with narrow, yellow scales and submedian patches of broad, dark scales dorsally; broad, appressed, yellowish-white scales laterally; torus yellow to yellowish brown with few pale scales on inner surface. **THORAX:** Scutum integument black with very broad median stripe of dark brown scales, much widened posteriorly, with pale-golden scales laterally and sometimes in the prescutellar space; pleura with small, separate, well-defined patches of silvery-white scales, not reaching propleuron on sternopleuron and covering only upper two-thirds of mesepimeron; postcoxal area, hypostigial area and metameron without pale scales; lower mesepimeral bristles usually absent, occasionally one. **ABDOMEN:** Tergites black-scaled with metallic blue lustre, with basolateral patches of white to yellowish-white scales; sternites mostly white-scaled, terminal segments with apices dark-scaled. **LEGS:** Blue-black-scaled, unbanded. **WINGS:** Scales narrow, dark.

MALE TERMINALIA—Lobes of **ninth tergite** about as long as broad, each with several stout spines. **Tenth sternite** heavily sclerotized apically. **Phallosome** subcylindrical, bluntly pointed and notched apically. **Claspette** stem short, stout, pilose, with short, stout, branch beyond middle; **filament** about as long as stem, very broad, flat, curved, leaflike, arising from tip of short branch of the stem. **Basistyle** about 3 times as long as wide; **basal lobe** rounded with many long, fine setae; **apical lobe** rounded, thumb-shaped, with several short curved setae. **Dististyle** about two-thirds as long as basistyle, pilose, with many small subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna almost as long as head; head hair 5 usually 5- to 8-branched; 6 usually 3- to 5-branched; hairs 5, 6 and 7 inserted in nearly straight line. **THORAX:** Prothoracic hair 1 long, single; 2 medium, single; 3 short, usually double. **ABDOMEN:** Comb scales in patch of 25 to 35, each scale fringed with stout subequal spines. **SIPHON:** Siphon index about 4.5 to 5.0; pecten teeth evenly spaced; dorsal preapical spine shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete, spiculate apically; lateral hair single, slightly longer than saddle; gills about as long as saddle, pointed.

BIONOMICS

Larvae of *A. thibaulti* have not been collected from New York which is north of their normal range. In the southeastern United States, they occur most often in the flooded hollow bases of trees, primarily gum trees, especially in "gum ponds" (Shields & Lackey, 1938; Carpenter & LaCasse, 1955). They have also been collected from woodland pools (Horsfall, 1939), floodplains of small streams (Shields & Lackey, 1938) and a "hummock" formed by the ball of earth attached to a fallen tree in Indiana (Siverly, 1972). Overwintering is in the egg stage, and there is a single generation a year. Horsfall (1939) found that eggs could withstand drying for at least 2 years until the site was flooded. In Indiana, larvae are found in April and adults appear about the first of May. In Alabama, larvae of *thibaulti* are found associated with *Culex restuans*, *C. territans*, *Culiseta melanura* and *Aedes triseriatus* (Shields & Lackey, 1938).

Adults rest in hollow trees and stumps, but fly short distances to feed during the day or night. Shields & Lackey (1938) observed that the females are not vicious biters, but Carpenter & LaCasse (1955) found them to be persistent and their bites painful. Hosts other than man have not been reported for *A. thibaulti*.

DISTRIBUTION

A. thibaulti is distributed through most of southeastern United States west to Texas and north to Ohio (Carpenter & LaCasse, 1955). Belton & French (1967) reported collecting one specimen of this species in Ontario, well north of its usual range. It has recently been reported for the first time from Indiana (Siverly, 1972); in biting collections from Connecticut and Chappaqua, Westchester County, New York (Wallis & Whitman, 1971); and biting collections from Monroe County (T. Bast, N.Y. State Health Department; Albany, New York, pers. comm., 1974).

IMPORTANCE

Despite examination of several pools of specimens for arboviruses, *thibaulti* has not been incriminated in the transmission of disease organisms (Sudia *et al.*, 1971). Since the species is rare in New York, it is of no importance as a pest species.

Aedes (Ochlerotatus) trichurus (Dyar)

Culex trichurus Dyar, 1904. Jour. N.Y. Entomol. Soc. 12:170. Type loc.: British Columbia, Canada.

Culex cinereoborealis Felt & Young, 1904. Science 20:312; Felt, 1904. Bull. N.Y. State Mus. 79:312. Type loc.: Ottawa, Ontario, Canada.

Aedes poliochros Dyar, 1919. Insec. Inscit. menstr. 7:35. Type loc.: Manitoba, Canada.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with narrow, white to grayish-white scales dorsally; broad, appressed, whitish scales and patches of dark scales laterally; torus brown with patch of white scales on inner surface. **THORAX:** Scutum integument dark brown, either entirely gray-scaled or with a broad, median stripe of brown scales, widening posteriorly; scutellum with grayish-white scales and dark-brown setae; pleura with dense patches of rather broad grayish-white scales extending on sternopleuron to propleuron and mesepimeron to lower margin; postcoxal area, hypostigial area and metameron with pale scales; lower mesepimeral bristles three to six. **ABDOMEN:** Tergites dark brown with basal white bands, usually widened laterally; sternites mostly pale-scaled, apices of segments usually with some dark scales. **LEGS:** Tarsi dark, unbanded. **WINGS:** Scales narrow, brown, usually with a patch of pale scales at base of costa.

MALE TERMINALIA—Lobes of ninth tergite bluntly rounded, about as long as broad, each with several strong setae. **Tenth sternite** heavily sclerotized apically. **Phallosome** long, cylindrical, fringed and with a nipplelike projection apically. **Claspette** stem very long, curved, slender, pilose on basal half, somewhat expanded near apex and bearing two subapical setae; **filament** less than one-fourth as long as stem, twisted, expanded near base, pointed at tip. **Basistyle** 3½ to 4 times as long as wide; **basal lobe** quadrangular with two or three long, strong, dorsal setae and with a ventral point bearing many fine shorter setae; **apical lobe** prominent but not conspicuous, rounded, with a few setae. **Diststyle** about half as long as basistyle, expanded medially, pilose, with three or four small subapical setae.

FOURTH INSTAR LARVA—HEAD: Antenna less than half as long as head; head hair 5 double or triple, 6 usually single. **THORAX:** Prothoracic hair 1 long, single; 2 short, single; 3 short, with 2 or more branches. **ABDOMEN:** Comb scales 10 to 20 (usually 12 to 16) in a double row, each scale thornlike with a stout median spine and smaller lateral spinules at base. **SIPHON:** Siphon index about 3.0; pecten teeth long, extending to distal fourth of siphon, outer four or five teeth detached; siphonal tuft large, inserted within pecten near basal third of siphon. Siphon with three or four small lateral branched hairs and four or five larger branched subdorsal hairs; dorsal preapical spine much shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete, almost meeting ventrally; lateralhhair single, shorter than saddle; gills longer than saddle, pointed.

BIONOMICS

Aedes trichurus has a typical Northern *Aedes* type of life cycle. Eggs are laid in depressions in wooded areas in late summer and are among the earliest to begin hatching in the spring, usually before all of the ice has gone from the pools. In warm regions of the State, first instar larvae appear in late March or early April and most adults are on the wing by late April or early May. In the Adirondacks and the northern counties of St. Lawrence, Franklin, and Clinton, where the species is most common, development is usually 2–3 weeks later.

The larvae are most often found in shallow temporary pools of melted snow or spring rains, in open bogs or swamps (Owen, 1937; Irwin 1941), or in sparsely wooded areas. The author has usually found this species in greatest abundance in shallow, lightly shaded, leaf-lined snowmelt pools at the edges of thin stands of young hardwoods, in open pasture, and in temporary cattail ponds and grassy roadside drainage ditches containing low brush. Because the period for larval development is rather long, often lasting for 4 weeks or more, the larvae are associated with several other species. The author has found its most common associates to be *A. canadensis*. *A. cinereus*, *A. punctor*, *A. vexans*, and *Culiseta morsitans dyari* are less often associated.

Females bite man readily during the day in shaded places; in early evening, in dwellings and open places. They are usually, as observed by Owen (1937), not as voracious as *A. communis*, with which they are commonly associated. Although the females are sometimes quite abundant locally, they appear to be relatively short-lived, rarely collected after early July.

Little has been reported regarding the hosts of *trichurus* other than man. Downe (1960) found that this species fed generally on mammals, the host species more a matter of availability than of preference, and to a limited extent on birds. Through serological examination of blood meals of *trichurus*, the following mammals were found to have served as hosts: human, horse, beef, dog, pig, goat, Raccoon, deer and rodent.

DISTRIBUTION

A. trichurus is distributed throughout most of the forested regions of northern United States and southern Canada. It is found in scattered localities throughout New York State north of New York City. It appears to be most abundant in the Adirondacks and far northern counties of Jefferson, St. Lawrence, Franklin, and Clinton.

IMPORTANCE

This species has not been incriminated in disease transmission. It is not usually very abundant but may sometimes become a severe local pest.

Aedes (Ochlerotatus) trivittatus (Coquillett)

Culex trivittatus Coquillett, 1902. Jour. N.Y. Entomol. Soc. 10:193. Type loc.: Chester, New Jersey.

Culex inconspicuous Grossbeck, 1904. Entom. News 15:332. Type loc.: Garret Mts., Paterson, New Jersey.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi dark-scaled; occiput with narrow, white scales dorsally; broad, appressed, dingy-white scales and dark patches laterally; torus brown, without scales. **THORAX:** Scutum integument dark brown, with pair of submedian stripes of white to yellowish scales, median and lateral stripes of dark-brown scales; pleura with distinct separate patches of appressed, grayish-white scales, not extending to propleuron or tm lower margin of mesepimeron; postcoxal area, hypostigial area and metameron bare; lower mesepimeral bristles absent. **ABDOMEN:** Tergites dark-brown to black-scaled with basolateral patches of white scales, sometimes with small, median, basal white patches on some segments; sternites pale-scaled. **LEGS:** Posterior surfaces of basitarsi white-scaled, otherwise tarsi dark-scaled, unbanded. **WINGS:** Scales narrow, dark brown.

MALE TERMINALIA—Lobes of ninth tergite about as long as broad, each with four to six stout spines. **Tenth sternite** heavily sclerotized on apical half. **Phallosome** conical, rounded and notched at apex. **Claspette** stem slender, pilose; **filament** about as long as stem, expanded to sharp retrorse projection at basal third, sometimes with one or more accessory retrorse spines; bladelike, tapering to curved apical point. **Basistyle** 3½ to 4 times as long as wide; **basal lobe** prominent, conical, with numerous long fine setae apically and large curved dorsal spine; **apical lobe** rounded, with few short setae. **Dististyle** about two-thirds as long as basistyle, slightly expanded medially.

FOURTH INSTAR LARVA—HEAD: Antenna less than half as long as head; head hairs 5 and 6 single. **THORAX:** Prothoracic hair 1 medium, single; 2 short, single; 3 short, usually single. **ABDOMEN:** Comb scales in patch of 15 to 25 or more, each scale thornlike with rather large subapical spines and long median spine. **SIPHON:** Siphon index about 2.0; pecten teeth evenly spaced, extending beyond middle of siphon; siphonal tuft less than three-fourths width of siphon at point of insertion; dorsal preapical spine shorter than apical pecten tooth. **ANAL SEGMENT:** Saddle complete; lateral hair single, almost as long as saddle; gills 2 to 3 times as long as saddle, pointed.

BIONOMICS

The larvae of *A. trivittatus* are found in open or partially shaded, temporary woodland pools, but usually not in dense forests (Abdel-Malek, 1948; Siverly, 1972). The typical habitat is a sparse forest in temporary rainpools of moderate depth, containing substantial vegetation. In Indiana and Ohio, overwintering eggs hatch in early May and produce the first emergence of adults in late May or early June. In Ohio (Abdel-Malek, 1948) and Indiana (Siverly, 1972), a second generation is evident in middle to late July, and, in the southern United States, the species is said to have several generations a year (Horsfall, 1955). Records indicate adult *trivittatus* are present in scattered localities throughout New York from June to September. They usually occur in small numbers, but Matheson (1944) reported that they were abundant following a flood in 1935. Dr. Thomas Bast of the New York State Health Department (personal communication, 1974, 1975) found this species to be quite abundant in central New York following heavy rains in 1972.

The larvae of *trivittatus* are commonly associated with larvae of *A. vexans* in Indiana and Ohio and with *Psorophora ferox* in Ohio. In addition, Horsfall (1955) reported that they are often associated with *A. canadensis*, *Psorophora varipes*, *P. horrida*, *P. howardii* and *P. ciliata* in Illinois. Larvae are short-lived, completing their development under normal summer conditions in Ohio in about 8 days. Abdel-Malek (1948) and Siverly (1972) both observed that late-instar larvae tend to remain close to the bottom for extended periods, thereby making it difficult to detect or collect them. Siverly recommended that they could best be collected by drawing the dipper across the bottom, especially near the bases of tree trunks and submerged logs.

Female *trivittatus* usually hide under thick vegetation near the larval breeding site during the day and leave to feed in early evening. They attack humans readily anytime during the day or night, and in bright sunlight if their resting place is disturbed. Abdel-Malek found that the areas of the body preferred for biting were the arms and head, especially behind the ears or just above the eyebrows. Other than humans, few hosts have been reported for this species. In precipitin tests of blood-engorged, wild, caught females, Edman & Downe (1964) found that this species also fed on beef, sheep, rabbit and fowl. Usually within 4–5 days after feeding, the females lay eggs in small batches totaling an average of 55 eggs and die within a few hours, sometimes on the water surface where the eggs were deposited (Abdel-Malek, 1948).

DISTRIBUTION

A. trivittatus is widely distributed throughout southeastern Canada, the United States and south into Mexico. It has been reported throughout New York State. It is seldom found in large numbers but was reported by Matheson (1944) to have occurred in great abundance in central New York following flooding in 1936. It also became quite abundant in localized areas of central New York following floods in 1972 (N.Y. State Health Department, unpublished records).

IMPORTANCE

Several strains of California Encephalitis viruses have been isolated from *trivittatus* in many regions of the country (Sudia *et al.*, 1971). Since it feeds readily on humans and large mammals, it is considered a locally important pest and a species of potential medical importance.

SUBGENUS *PROTOMACLEAYA* THEOBALD

Protomacleaya Theobald, 1907. Monogr. Cul. 4:149, 253–254. Type species: *Culex triseriatus* Say, 1823, by monotypy.

IMPORTANT REFERENCE: Zavortink (1972).

The subgenus *Protomacleaya* was resurrected from synonymy with *Finlaya* by Zavortink (1972), who reviewed the New World species previously placed in *Finlaya*. Two treehole breeding species which occur in New York have been placed in this subgenus, *triseriatus* Say and *hendersoni* Cockerell, the latter reported as occurring in New York for the first time by Zavortink (1972).

Males of the subgenus *Protomacleaya* may be characterized as follows: **PALPI** subequal in length or slightly longer than proboscis. **TERMINALIA: Lobes of ninth tergite** prominent, narrowly connected middorsally, each with one to nine moderately to strongly developed setae. **Tenth sternite** prominent, heavily sclerotized apically. **Phallosome** moderately large, without teeth; base slightly bulbous, remainder subparallel-sided, truncate at apex. **Claspette stem** short, straight, spiculose, with two to six weakly developed setae; **filament** long, flattened apically, curved or angled dorsally, without retrorse barb. **Basistyle** well developed, elongate, subcylindrical to subconical; basal tergomesal area slightly swollen; median sternomesal area with a conspicuous tuft of setae; **apical lobe** absent. **Dististyle** simple, short; swollen and spiculose basally; apical portion with longitudinal ridges and with one or two fine setae on inner surface; **apical claw** slightly curved, about one-third to one-half as long as dististyle.

Characteristics separating the two species of this subgenus are included in the synopses of the species.

Aedes (Protomacleaya) hendersoni Cockerell

Aedes triseriatus var. *hendersoni* Cockerell, 1918. Jour. Econ. Entomol. 11:199. Type loc.: Box Elder Creek, 19 mi. w. Douglas, Wyoming. 25 Aug. 1917, E. Schwabe & J. Henderson (selection of Stone & Knight, 1956:218); reduced to synonymy with *triseriatus* by Dyar (1919:39); resurrected to specific rank by Breland (1960).

Aedes (Finlaya) hendersoni Cockerell. Breland 1960:600–606.

Aedes (Finlaya) triseriatus, in part, authors.

Aedes triseriatus (Say), in part, authors.

For complete synonymy, see Zavortink (1972:20).

IMPORTANT REFERENCES: Zavortink (1972), Breland (1960).

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi black, occiput with narrow, curved, silver-white scales dorsally; broad, appressed, white scales laterally; torus brown, without scales. **THORAX:** Scutum with broad median stripe of narrow, dark-brown scales, much widened posteriorly, bordered laterally with wide anterior band of white lanceolate scales; prescutellar space with wide border of white lanceolate scales; anterior, dorsocentral and lateral regions of scutum with many conspicuous setae and bristles; middle lobe of scutellum white-scaled; pleura with dense, well-defined, separated patches of appressed, silver-white scales, extending on sternopleuron about halfway to propleuron, not reaching lower margin of mesepimeron; postpronotum entirely white-scaled; hypostigial area, postcoxal area and metameron without scales; lower mesepimeral bristles absent. **ABDOMEN:** Most tergites blue-black-scaled with large basolateral patches of silvery-white scales rounded mesally; sternites white-scaled with apical bands of dark scales on terminal segments. **LEGS:** Tibia and tarsi blue-black-scaled, often with pale scales on posterior surface; claws of fore and midlegs abruptly and sharply curved, each with long tooth. **WINGS:** Scales narrow and dark; with small basal patch of white scales.

MALE TERMINALIA—Phallosome about 2.0 to 2.1 times longer than greatest width. **Claspette filament** angulate. **Basistyle** with tergal sclerotization conspicuously broadened distally, so that tergal surface appears constricted near level of claspette filament; **basal tergomesal area** usually greatly swollen, with numerous elongate setae in an oval to circular patch; **median tergomesal** sclerite strongly developed, triangular, projecting far into mesal membrane; **sternomesal tuft** strongly developed, consisting of numerous setae, many sharply curved cephalad and/or dorsad.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head, smooth, its tuft represented by single hair; head hair 5 usually single (occasionally double or triple), 6 usually 3- to 4-branched. **THORAX:** Pigment absent, living larva white in color; prothoracic hair 1 long, 2- to 4-branched; 2 medium, single; 3 short, 2- to 4-branched. **ABDOMEN:** Abdominal hair 1 of segments I to VI stellately branched; hair 4 of segments III and IV usually double; comb scales 8 to 16 arranged in single or irregular row, each scale about as long as pecten tooth, tapered, fringed with short spinules. **SIPHON:** Siphon index 2.5 to 3.4; acus detached and usually removed from base of siphon; pecten teeth evenly spaced, short, moderately pigmented; siphonal tuft 2- to 3-branched; dorsal preapical spine usually as long as or longer than distal pecten teeth. **ANAL SEGMENT:** Saddle incomplete, covering dorsal half of segment; lateral hair slightly longer than saddle, usually double, located near caudolateral angle or at edge or in unsclerotized notch on posterior margin of saddle; ventral brush with five pairs of hairs; gills sausage-shaped, dorsal and ventral pairs subequal, 3 to 4 times as long as saddle.

BIONOMICS

Little is definitely known about the biology of *A. hendersoni.* The larvae develop in holes in many species of deciduous trees (Siverly, 1972; Truman & Craig, 1968; Zavortink, 1972; Breland, 1960) and in artificial containers (Loor & DeFoliart, 1970) containing water of very high organic content. *A. hendersoni* larvae are frequently found associated with larvae of *A. triseriatus* and hybridization of these two species has been observed (Truman and Craig, 1968). Larvae of *hendersoni* have also been found associated with other treehole species including *Anopheles barberi*, *Orthopodomyia alba*, *O. signifera* and *Toxorhynchites rutilus septentrionalis* as well as other species which have not been reported from New York (Zavortink, 1972; Breland, 1960; Truman & Craig, 1968; Loor & DeFoliart, 1970).

Assuming *A. hendersoni* is similar to *A. triseriatus* in its life cycle, eggs are laid on the sides of a treehole or artificial container just above the water line, singly or in small groups. Although Loor & DeFoliart (1970) found that the site location preferred for oviposition by *triseriatus* was at or near ground level, the author has collected larvae of both *triseriatus* and *hendersoni* in New York from sites ranging from ground level to 10 feet above the ground.

Eggs overwinter attached to the sides of the cavity and hatch when water, which must be highly organic (Truman & Craig, 1968), covers them and reaches a suitable temperature of about 22–25° C. First instar *hendersoni* larvae have been collected from discarded tires in Rensselaerville, Albany County, as early as May 15, 1974 and adults appear and begin biting by mid-June. Several subsequent generations throughout the summer produce a peak adult population at about mid-August, as reported for *A. triseriatus* (Loor & DeFoliart, 1970). According to Breland (1960), the eggs of *hendersoni* may be better able to withstand drought conditions than those of *triseriatus.* Larvae of both *hendersoni* and *triseriatus* often graze on the water surface, but are easily disturbed and may conceal themselves in the bottom mud and debris for several minutes before resurfacing.

Although little is known about the habits and hosts of the adults, the females are known to bite man (Zavortink, 1972) and are most active in early evening. They readily enter houses in search of a blood meal (Harmston & Lawson, 1967) and, like *triseriatus*, feed intermittently on the same or different hosts.

DISTRIBUTION

Until recently, *hendersoni* was thought to occur only in the Midwestern States. However, Zavortink (1972) reported that this is the most widespread treehole breeding mosquito in North America. It occurs in all of the continental United States except possibly the extreme Southwest, throughout southern Canada and possibly northeastern Mexico. The occurrence of *A. hendersoni* in New York was based on specimens labeled as *triseriatus* in museum and university collections. The present author has found that *hendersoni* is widely distributed in New York. In the St. Lawrence, Hudson and Mohawk River Valleys and the Adirondacks, Helderbergs and Catskills, *hendersoni* occurs about as frequently as *triseriatus.* It can be found in many water-holding treeholes and in some artificial containers at some time during the summer. West and south of these regions, *hendersoni* appears to be much less common than *triseriatus.*

IMPORTANCE

A. hendersoni has not been incriminated in disease transmission, however, because it has been confused taxonomically with *A. triseriatus*, it may be a vector of one or more of the pathogens which *triseriatus* is suspected or proven to transmit (see discussion under *A. triseriatus*). Since the habits of female *hendersoni* appear to be very similar to those of *triseriatus* (e.g., crepuscular, intermittent feeding), it is possible that this species will be found to serve as a vector for the same diseases.

Aedes (Protomacleaya) triseriatus (Say)

Culex triseriatus Say, 1823. Jour. Acad. Nat. Sci. Philadelphia, 3:12. Type loc.: Pennsylvania.

Finlaya nigra Ludlow, 1905. Can. Entomol. 37:387. Type loc.: Rock Island Arsenal, Illinois.

DIAGNOSIS

FEMALE—HEAD: Proboscis and palpi black-scaled; occiput with narrow, curved, silvery-white scales dorsally; broad, appressed, white scales laterally; torus brown, without scales. **THORAX:** Scutum integument brown to black with broad, median stripe of dark-brown to black scales, much widened posteriorly, silvery-white scales laterally and in prescutellar space; relatively few bristles on anterior portion and dorsal surface of mesonotum; scutellum with white scales on middle lobe and dark-brown bristles; pleura with dense, distinct patches of closely appressed, silvery-white scales, on sternopleuron separate from patch on prealar area, not extending to propleural patch, on mesepimeron not extending to lower margin; postcoxal area, hypostigial area and metameron bare; lower mesepimeral bristles absent. **ABDOMEN:** Tergites blue-black-scaled with basolateral white patches; sternites pale with dark apical bands on terminal segments. **LEGS:** Tarsi black-scaled, unbanded; claws of fore and mid-legs usually evenly curved, with short tooth. **WINGS:** Scales narrow, dark.

MALE TERMINALIA—Phallosome about 2.2 to 2.3 times longer than greatest width. **Claspette filament** more or less evenly curved. **Basistyle** with tergal sclerotization progressively narrowed distally, not appearing constricted; **basal tergomesal area** only slightly swollen, with few elongate setae; **median sternomesal sclerite** moderately developed, rounded; **sternomesal tuft** moderately developed, with few sharply curved setae.

FOURTH INSTAR LARVA—HEAD: Antenna about half as long as head, smooth, its tuft represented as single hair; head hair 5 usually single (occasionally double); hair 6 usually double (occasionally 3- or 4-branched). **THORAX:** Pigment present, living larva dark in color; prothoracic hair 1 long, 2- to 4-branched; 2 medium, single; 3 short, 2- to 4-branched. **ABDOMEN:** Abdominal hair 1 of segments I to VI stellately branched; hair 4 of segments III and IV usually single; comb scales usually 8 to 16 in single or irregular double row, each scale about as long as pecten teeth, tapered, fringed with short spinules. **SIPHON:** Siphon index 2.5 to 3.0; acus attached at base; pecten teeth long, usually dark-pigmented, evenly spaced; siphonal tuft usually double; dorsal preapical spine shorter than apical pecten teeth. **ANAL SEGMENT:** Saddle incomplete, usually extending 0.5 to 0.65 down lateral surface of saddle; lateral hair usually 4- to 5-branched, slightly shorter than saddle, located on saddle and removed from edge by 2 or 3 alveolar diameters; ventral brush with six pairs of hairs; gills usually tapering distally, dorsal pair usually much longer than ventral pair, usually 1.0 to 1.5 times as long as saddle.

BIONOMICS

A. triseriatus is probably the most common treehole breeder in New York, and one of the most common throughout the United States. It breeds in a wide variety of natural and artificial containers and has several generations a year depending upon fluctuation of the water level in these containers. Eggs are normally attached singly to the inside wall of a treehole or artificial water container at or just above the water level (Newkirk, 1955). Suitable breeding sites for this species include holes in several species of trees, partially covered rain barrels, discarded buckets, cans, jars and tires. The author has found larvae breeding in water-holding cavities of a wide variety of trees including Beech, White Birch, several species of oak and maple, Hemlock, Ironwood, Sycamore White Pine, Red Pine and Box Elder and all types of artificial containers, especially ones which are shaded and contain rather highly organic water. They occur in many types of cavities ranging from large ground-level holes and hollowed-out stumps to holes only ½ to 1 inch in diameter several feet above the ground (figs. 30, 31).

Although larvae hatching from overwintering eggs have been collected as early as March 18th in Delaware (Lake, 1954) and April 10th in the vicinity of Albany, New York by the author, eggs normally begin hatching in early to mid-May in most of the State. De-

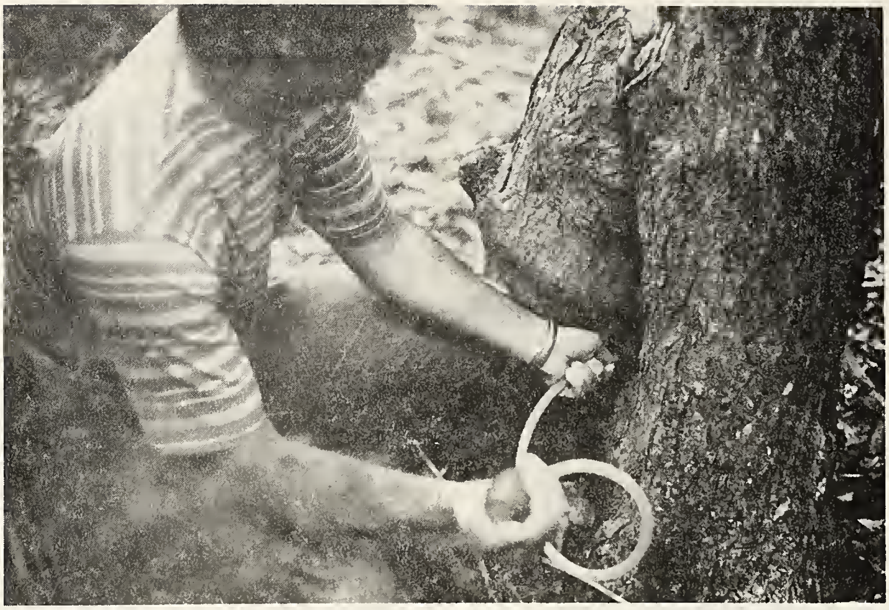

Figure 30. Treehole at base of maple, habitat for larvae of *Aedes hendersoni* and *A. triseriatus*

velopment of the aquatic stages under field conditions in New York usually takes about 2 to 3 weeks, depending upon temperature and light conditions. Those hatching late in the season usually take much longer.

Love & Whelchel (1955), McHaffey and Harwood (1970), Wright & Venard (1971), Venard *et al.* (1968) and others have shown that diapause of larvae and development of immature stages is greatly affected by the photoperiod and temperature, and that larval development takes place only under summer lighting conditions. Larvae can usually be found in suitable habitats throughout the summer until September, October or early November in most of New York. They are usually found in several stages of development in the same site. This is due to overlapping of successive generations and to eggs being deposited at different levels on the container walls by the same or different females and hatching at different times when water reaches them. Larvae of *triseriatus* and *hendersoni* are sometimes found occupying the same site at the same time, but late instars of one species are usually found with early instars of the other, indicating that they may alternate generations thereby avoiding competition. The larvae of both species appear to be negatively phototropic, seeking the more shaded portions of the site. They are easily disturbed and secrete themselves under leaves, other debris or mud, but usually return to the surface within a minute or two. It is usually convenient to collect these species from tires and other large containers using a small dipper or cup, but treeholes are usually difficult to sample in this manner. Often, especially if the opening is small or the cavity contains only a small amount of water, it is easier to siphon part or all of the water using apparatus described earlier under "collection methods." It is sometimes worthwhile to add water to an apparently empty treehole, especially if it is moist on the sides or bottom, to determine if larvae are present. The author has observed that larvae can live in mud for rather long periods and can survive for 2 weeks or more on slightly moist filter paper.

Adult female *triseriatus* are crepuscular, feeding primarily in the morning and early evening and very little after dark or during the day. They will bite during the day if disturbed, especially in shady, wooded areas. They bite readily in open areas adjacent to wooded areas, and do not normally fly far from such places. The author has occasionally encountered both *triseriatus* and *hendersoni* biting in dwellings near breeding areas, but never in abundance. The females frequently hover about the head then quickly dart in to begin feeding on the upper part of the body. They are easily disturbed and frightened off while biting, but usually resume on the same or another host rather quickly.

Benach *et al.* (1971) reported that *triseriatus* was indiscriminate in its feeding habits in the laboratory, feeding readily on mammals (rat and Guinea Pig), bird (chicken), reptile (Bullfrog) and amphibian (Box Turtle). The chicken was preferred in olfactometer tests.

Field-collected specimens had fed on deer, birds and reptiles. Wright & DeFoliart (1970) also found *triseriatus* fed on a variety of animals including Whitetail Deer, Raccoon, Red Fox, Opossum, Domestic Rabbit, Eastern Cottontail, Woodchuck, Gray Squirrel, Eastern Chipmunk and Western Painted Turtle. The author has observed them feeding, not only on man, but also on horse, cow, dog, cat and deer.

DISTRIBUTION

A. triseriatus occurs in Eastern North America from Canada south to Mexico, west to Montana, Wyoming, Colorado and Texas. It is common throughout New York State, and is most abundant in deciduous forest areas. In areas where treeholes and/or artificial containers such as discarded tires or rain barrels are abundant, this is often a very common mosquito species during July and August.

IMPORTANCE

With its wide host range and its intermittent feeding habits, *triseriatus* is potentially an efficient vector for a variety of disease organisms. It was suggested as a possible vector of canine filariasis. *(Dirofolaria immitis)* by Yen (1938) and Phillips (1939) and was listed as a potentially important vector of this disease by Ludlam *et al.* (1970). Several isolations of California Encephalitis viruses, especially La Crosse Virus, have been made from *triseriatus* in recent years (Sudia *et al.*, 1971). Gauld *et al.* (1974) stated that this species appears to be the principal vector in Wisconsin.

Since there have been several human cases of California Encephalitis virus infection in New York in recent years (M. Grayson, N.Y. State Health Department, Albany, New York, pers. comm., 1975) and since heartworm has also become more prevalent and widespread in the State (C. Morris, N.Y. State Health Department, Syracuse, New York, pers. comm., 1975), *A. triseriatus* is considered of great importance as a possible vector of these diseases. In addition, *triseriatus* is also a pest species, especially in and near wooded areas and dumps.

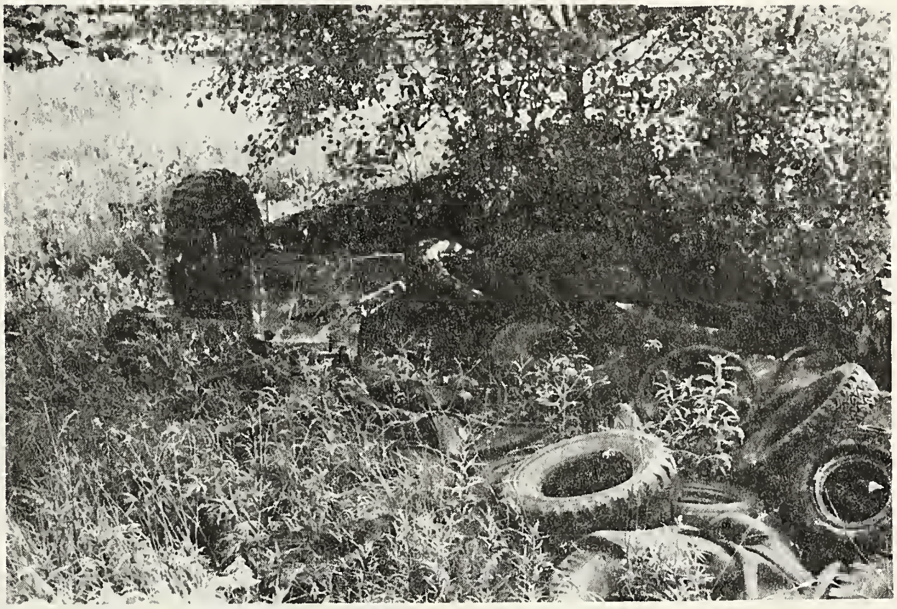

Figure 31. Discarded tires, a common habitat for larvae of *Aedes triseriatus*

SUBGENUS *STEGOMYIA* THEOBALD

Stegomyia Theobald, 1901. *In* Howard, Mosquitoes: 235; 1901. Jour. Trop. Med. 4:235; 1901. Mem. Liverpool School Trop. Med. 4. app. ii; 1901. Monogr. Cul. 1:283. Type species: *Culex fasciatus* Fabricius, 1805 [*Aedes aegypti* (Linnaeus), 1762], by monotypy.

For complete synonymy, see Stone *et al.* (1959), Belkin (1962) and Christophers (1960).

The subgenus *Stegomyia* is confined to the Old World with the exception of *aegypti* which has been introduced to the New World including the Southern United States.

Aedes (Stegomyia) aegypti (Linnaeus)

Culex aegypti Linnaeus, 1762. *In* Hasselquist, Reise nach Palestina: 470. Type loc.: Egypt.

For synonymy, see Stone *et al.* (1959); for bionomics and systematics, see Christophers (1960).

DIAGNOSIS

FEMALE—HEAD: Proboscis dark-scaled, palpi dark with silvery-white scales at apex; occiput with narrow median line of broad white scales; large submedian patches of broad dark scales; broad, appressed, white scales laterally and around eye margins; torus black with silvery-white scales. **THORAX:** Scutum integument dark brown to black, clothed with dark-brown scales with "lyre-shaped" pattern of yellowish-white and silvery-white scales, small patch of silvery-white scales on anterior margin and silvery-white scales surrounding prescutellar space; pleura with small separate patches of broad, appressed, silvery-white scales; small patch on sternopleuron extending only halfway to propleuron; prealar area with few scales; upper two-thirds of mesepimeron with two small separate patches; postcoxal area, hypostigial area and metameron bare; lower mesepimeral bristles absent. **ABDOMEN:** Tergites dark-scaled with narrow basal bands and basolateral patches of silvery-white scales; sternites white-scaled except last two segments mostly dark-scaled. **LEGS:** Segments 3–5 of fore and mid-tarsi dark-scaled, segment 5 of hind tarsus white-scaled, other segments dark-scaled with basal white bands. **WINGS:** Scales narrow, dark.

MALE—Palpi about as long as proboscis. **TERMINALIA—Ninth tergite** with large triangular lobes bearing few very small setae apically. **Tenth sternite** bluntly rounded apically with ventral branch near base. **Phallosome** conical, divided into two lateral plates, each with row of strong teeth at tip. **Claspette** absent. **Basistyle** short and stout with large scales and long setae; **basal lobe** represented by stout, apically bent spines and dense patch of setae; **apical lobe** absent. **Dististyle** slightly expanded near middle, with setae in addition to claw apically.

FOURTH INSTAR LARVA—HEAD: Antenna about one-third as long as head, smooth, its tuft represented by single short hair; head hairs 5, 6 and 7 single, hair 6 almost directly in front of hair 5. **THORAX:** Prothoracic hair 1 medium, 2- to 5-branched; 2 short, single; 3 short, double or triple. **ABDOMEN:** Comb scales 7 to 12 arranged in curved row, each scale thornlike with a strong median spine and short, stout, lateral spines, about as long as apical pecten tooth. **SIPHON:** Siphon index about 2.0; pecten teeth evenly spaced, extending to middle of siphon; dorsal preapical spine as long as apical pecten tooth. **ANAL SEGMENT:** Saddle incomplete; lateral hair single or double, about as long as saddle; gills about 3 times as long as saddle, bluntly rounded; dorsal brush consisting of long lower caudal hair and 2- to 4-branched upper caudal tuft.

The following information is summarized, except where noted, from a thorough account of the life history, bionomics and structure of *A. aegypti* by Christophers (1960).

BIONOMICS

Larvae of *aegypti* occur almost entirely in artificial containers such as flower pots, cisterns, vases, tubs, barrels, tires, tin cans and innumerable other water-holding containers. They are sometimes found in natural containers such as leaf axils, and rot cavities of trees (Carpenter & LaCasse, 1955).

Eggs are usually cemented to the sides of the container just above the water level, but may be deposited on the water surface, especially in glass containers. After conditioning, or ripening for several days (usually 2 to 4, but up to about 12, depending on temperature), eggs hatch when completely submerged. Under conditions of high humidity and low temperature, eggs may remain viable for more than a year, but viability is usually greatly reduced after 2 to 4 months. In tropical regions, breeding is continuous throughout the year while in cooler regions such as Southern United States, there are several generations during the summer. Overwintering occurs in the egg stage.

Host records for adult females have been summarized by Christophers. While human blood is apparently preferred, this species also feeds naturally on many species of domestic and wild animals and birds and has been induced to feed on frogs and turtles to a limited degree.

DISTRIBUTION

A. aegypti is distributed throughout much of the world, north in the Eastern Hemisphere to about the 35° F. January isotherm, with occasional isolated records as far north as New York, Boston, Oklahoma, Missouri and Indiana. When wooden sailing vessels offered good breeding places, it was prevalent along the east coast as far north as Boston, Philadelphia and New York (Chandler, 1945). Its occurrence in New York now is rare. There is no indication that overwintering normally occurs north of the deep Southern States.

IMPORTANCE

A. aegypti has long been notorious as the chief vector of yellow fever virus and dengue virus primarily in the tropics, and historically as far north as Boston and New York. It has also been incriminated as a vector of several other virus diseases pathogenic to man and animals including Eastern, Western and California Encephalitis (Sudia *et al.*, 1971; Davis, 1940). It has been termed an active vector of *Dirofilaria immitis* to dogs. Since this species occurs only rarely in New York and is not likely to overwinter here, it is not an important species in the State. If local infestations are found, they should be considered of potential medical importance.

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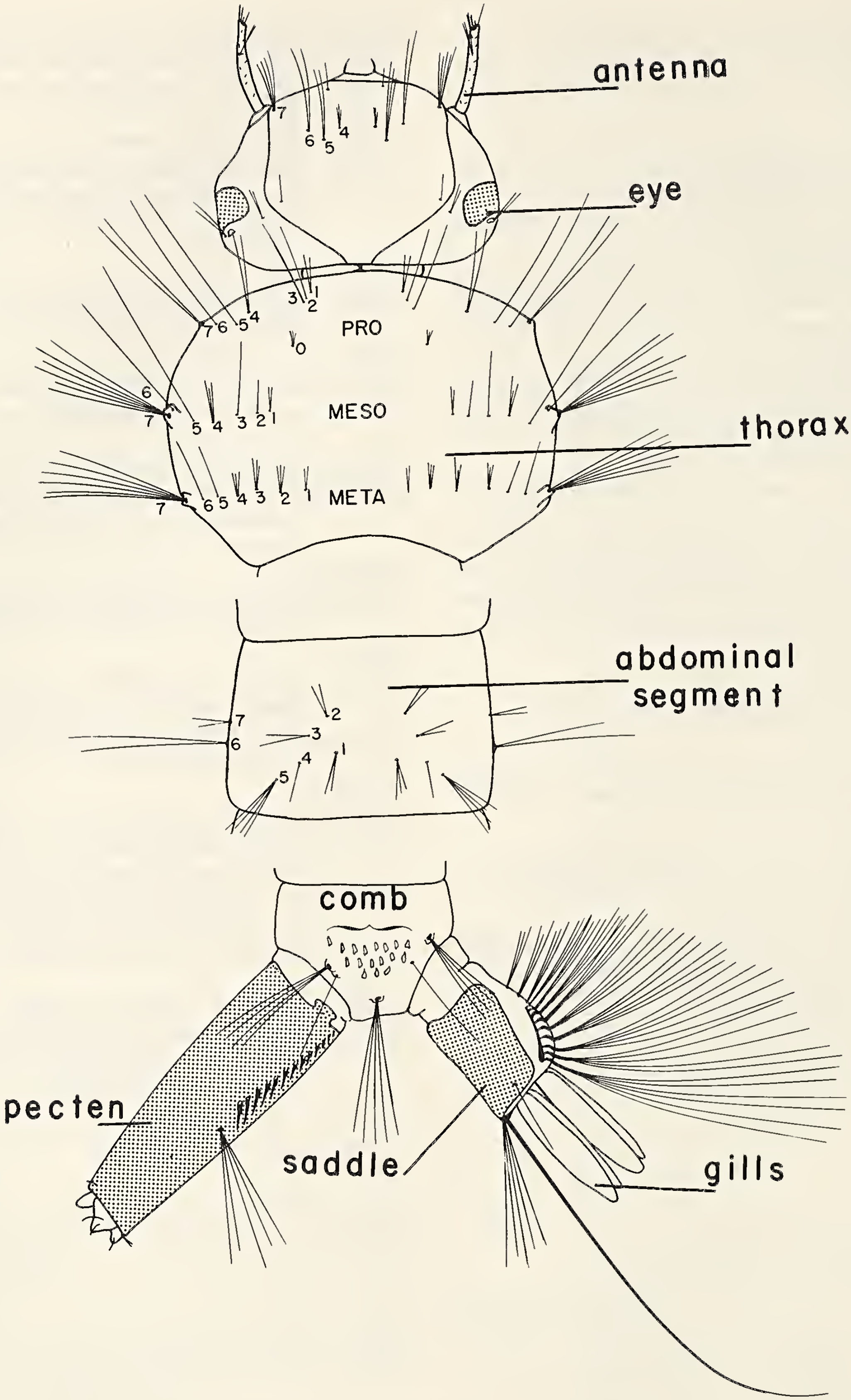


Figure 32. Generalized culicine mosquito larva

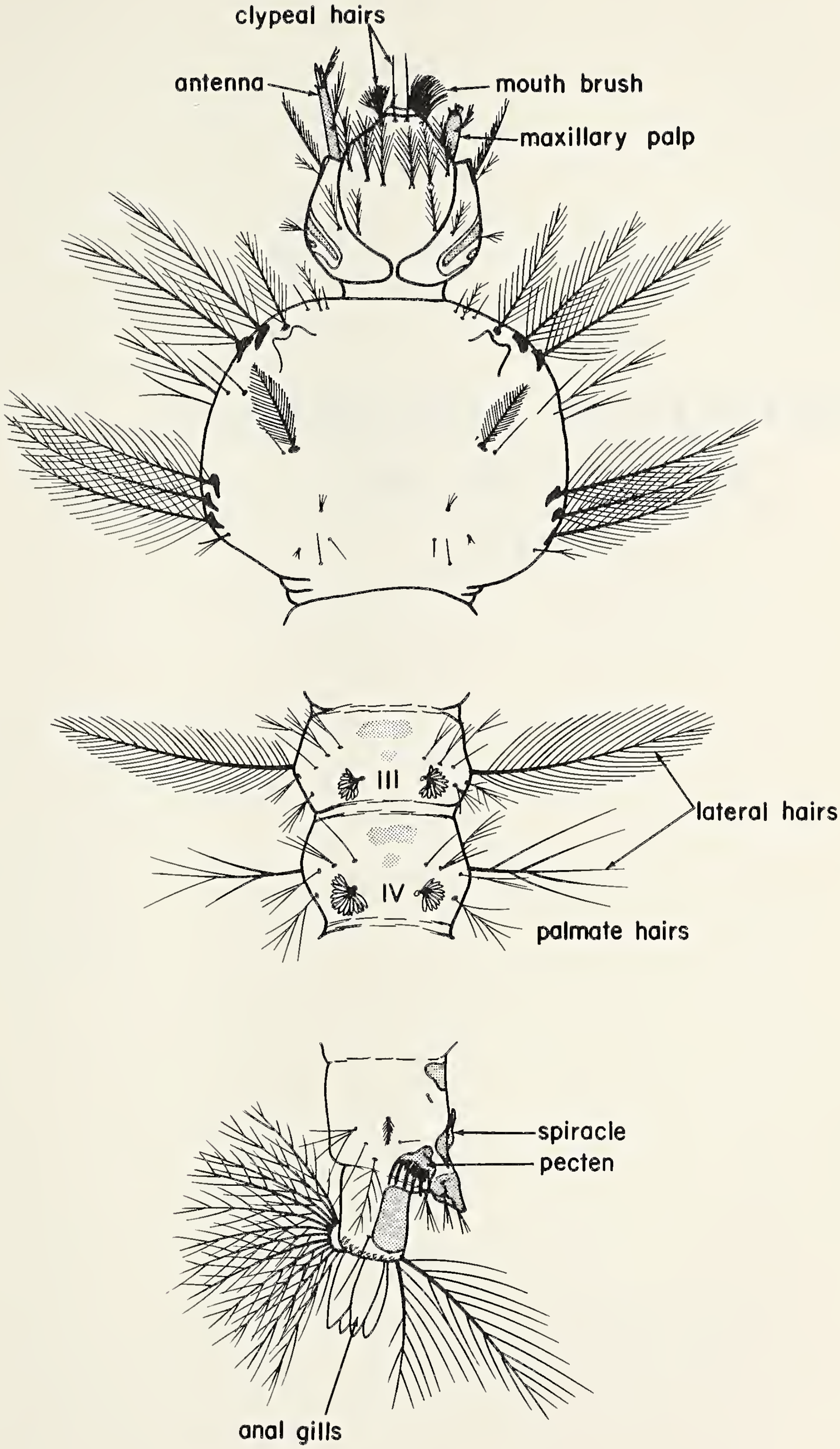
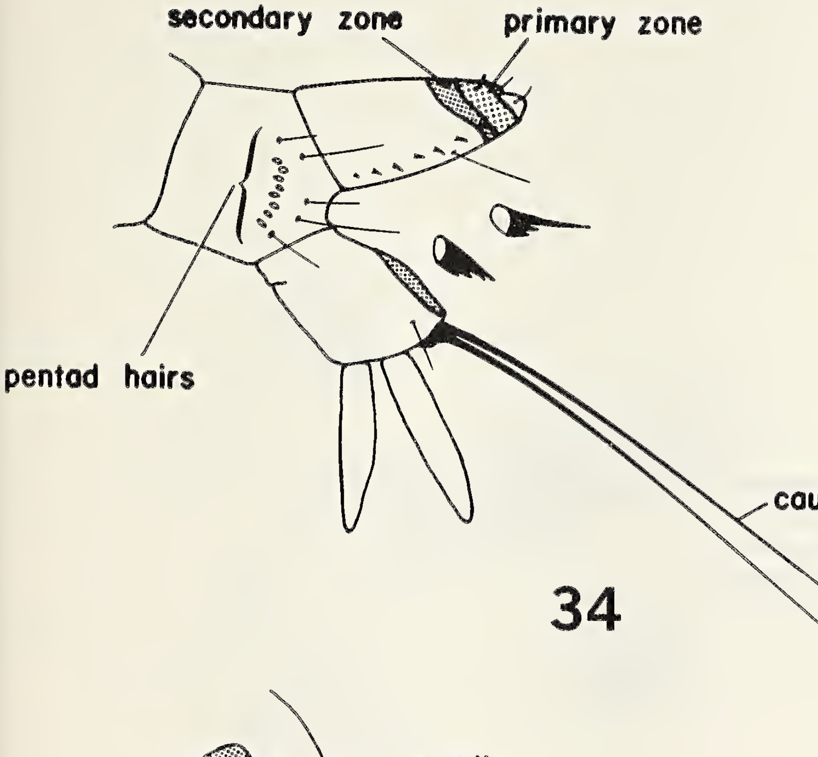


Figure 33. Generalized anopheline mosquito larva

PLATES FOR MOSQUITOES OF NEW YORK
PART I

Plate I

Figures 34. *Aedes atropalpus*, terminal segments of first instar larva
35. *Aedes triseriatus*, head of first instar larva
36. *Toxorhynchites r. septentrionalis*, terminal segments of first instar larva
37. *Anopheles punctipennis*, head of first instar larva
38. *Aedes vexans*, metathoracic tuft of second instar larva
39. *Aedes vexans*, saddle of third instar larva



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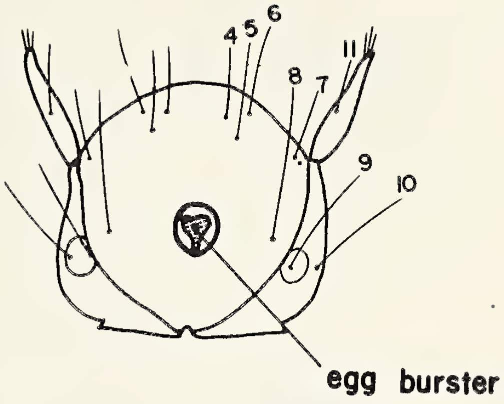

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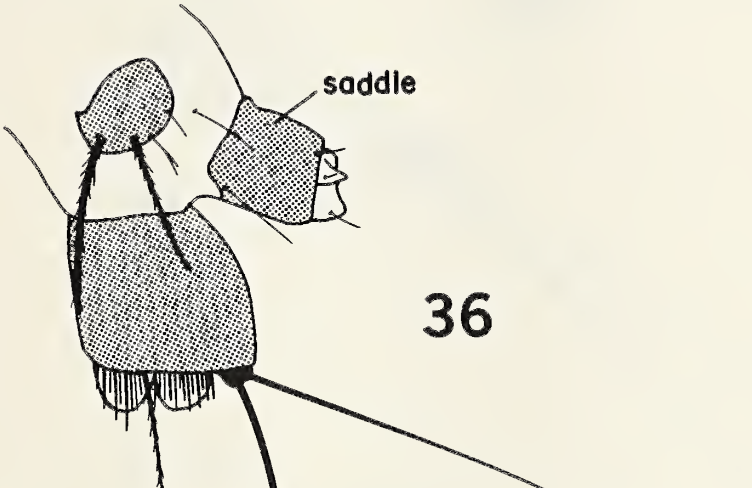

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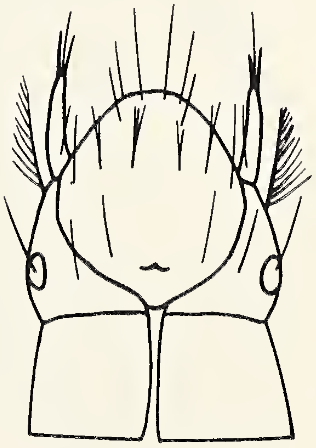

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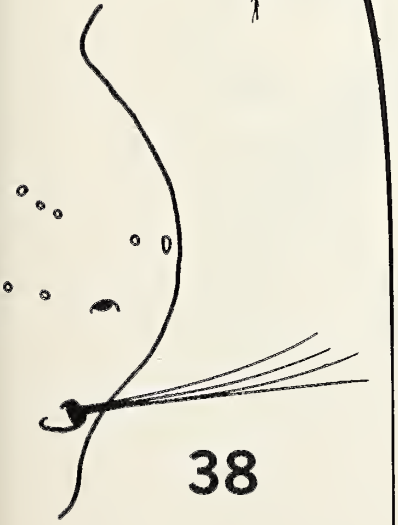

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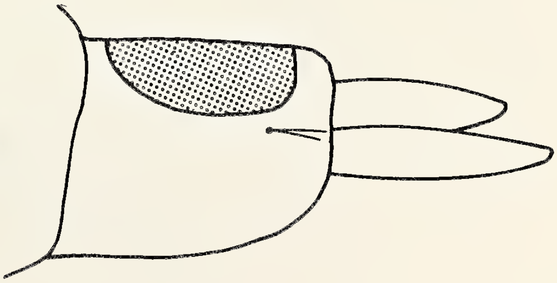

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Plate II

Figures 40–42. Terminal segments of first instar larva, a. comb scale, b. pecten tooth

40. *Uranotaenia sapphirina*
41. *Orthopodomyia signifera*
42. *Wyeomyia smithii*

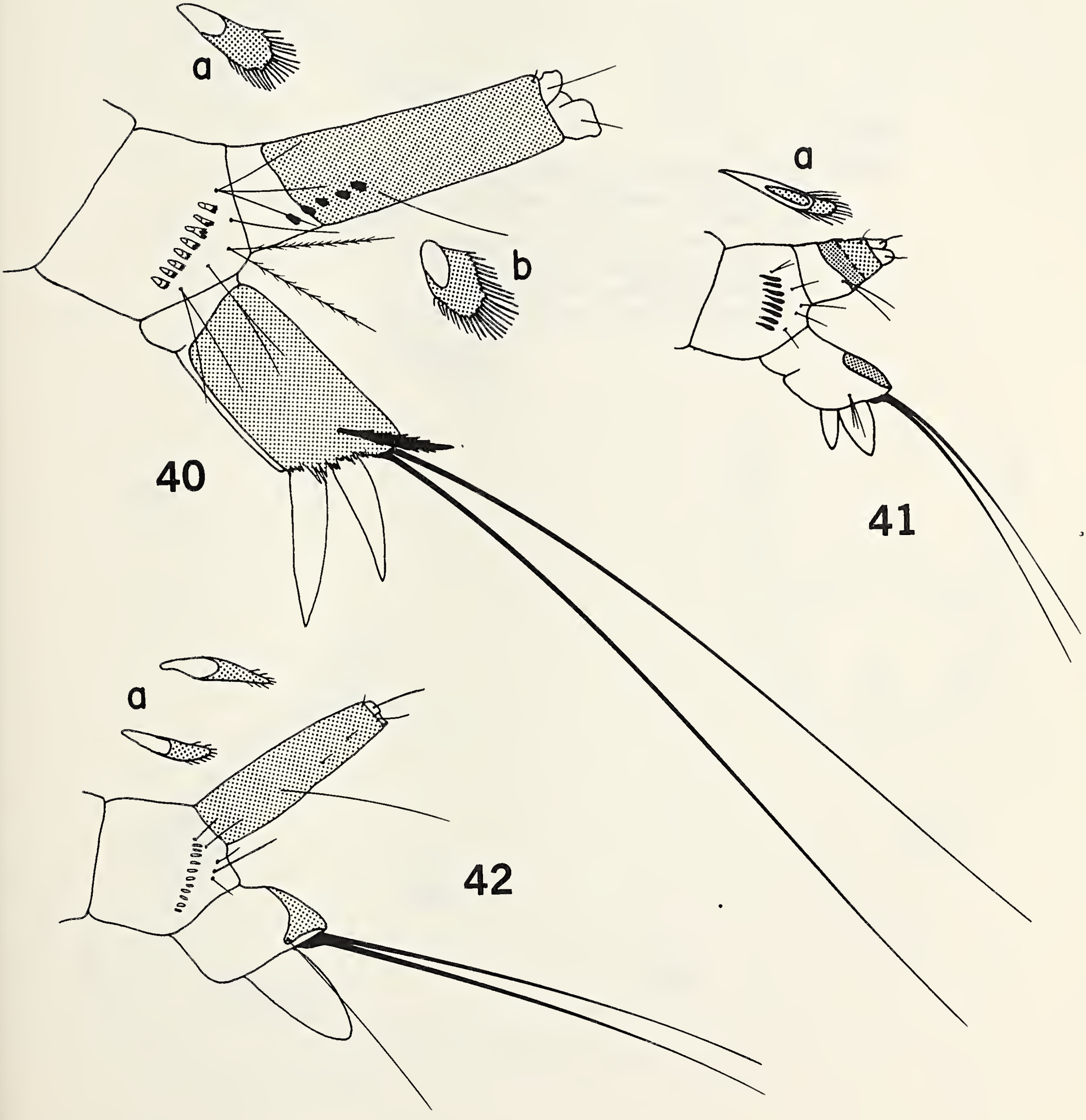

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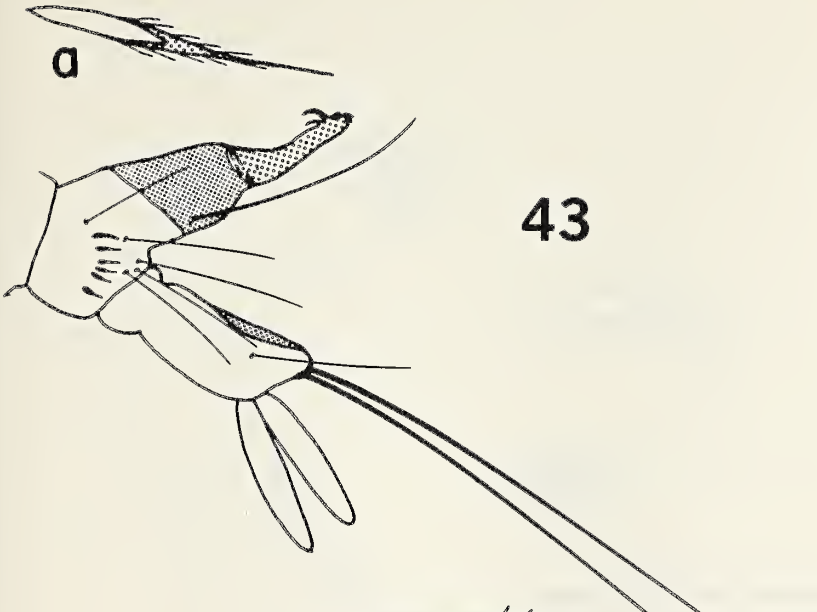
Plate III

Figures 43–44. *Coquillettidia perturbans,* first instar larva
43. Terminal segments, a. comb scale
44. Head
45–46. Terminal segments of first instar larva
45. *Culiseta morsitans,* a. comb scale
46. *Culex territans,* a. comb scale
47. *Psorophora ferox,* head of first instar larva



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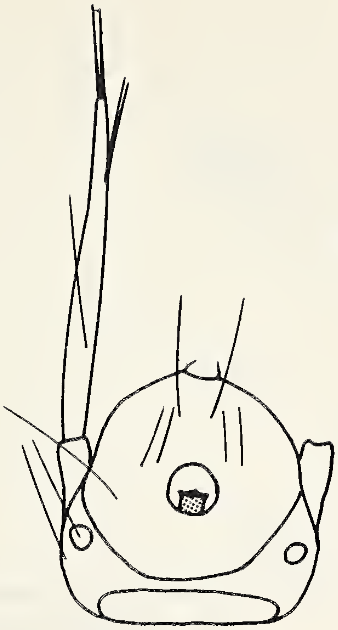

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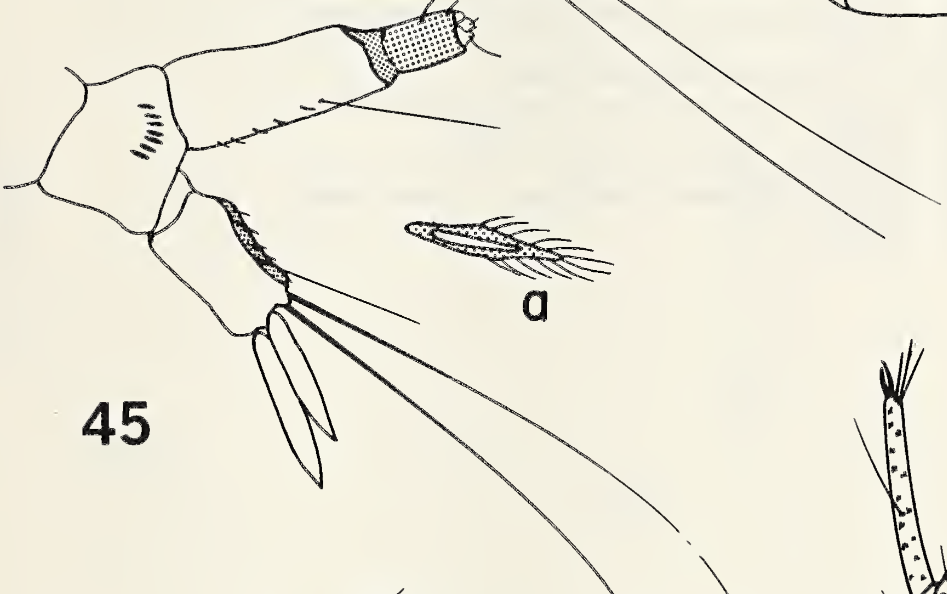

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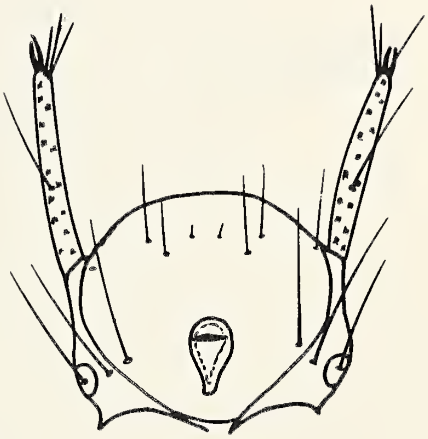

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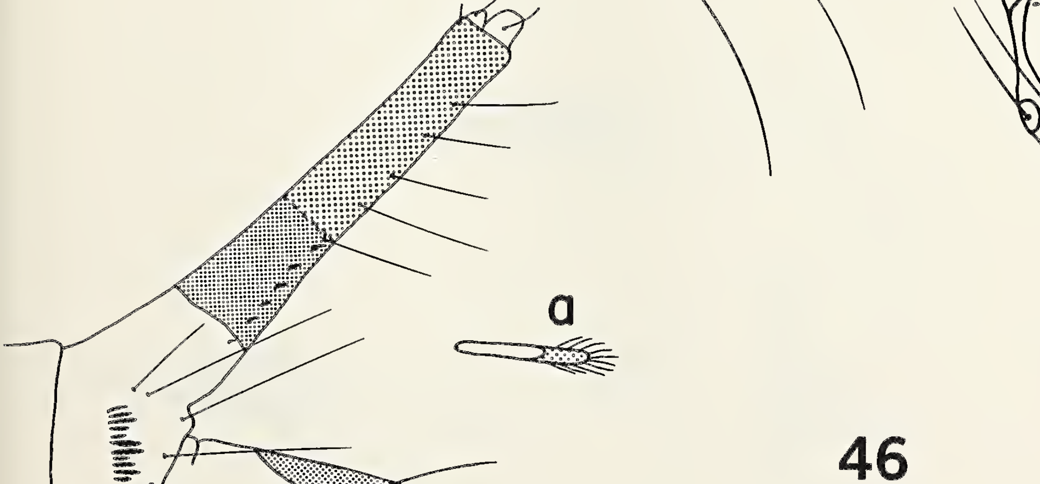

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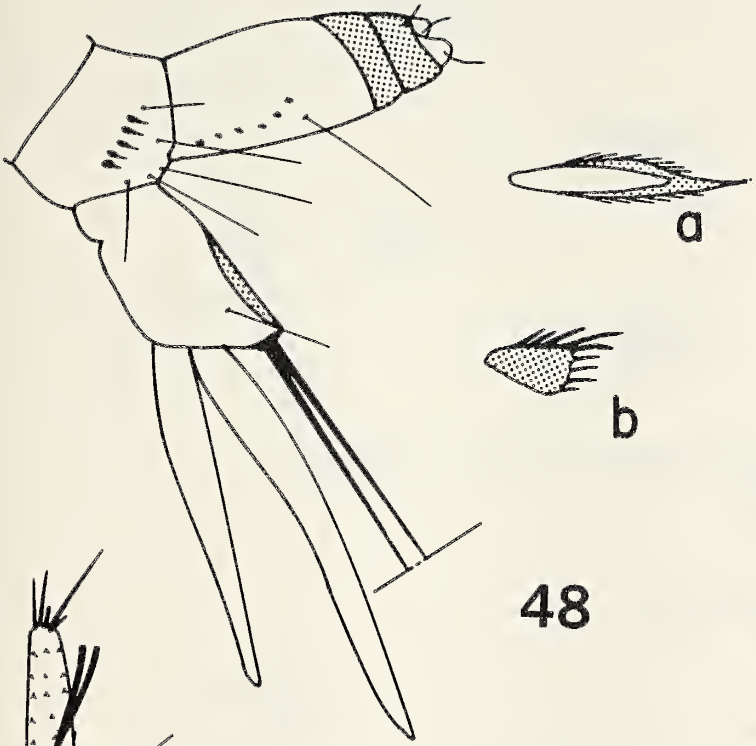
Plate IV

Figures 48–49. *Aedes atlanticus,* first instar larva
48. Terminal segments, a. comb scale, b. pecten tooth
49. Antenna
50–51. A. *trivittatus,* first instar larva
50. Terminal segments, a. comb scale, b. pecten tooth
51. Head
52–53. A. *fitchii,* first instar larva
52. Terminal segments, a. comb scale, b. pecten tooth
53. Antenna



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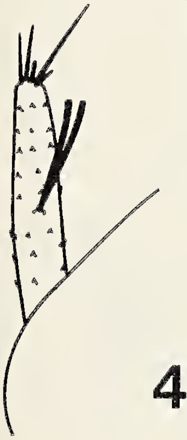

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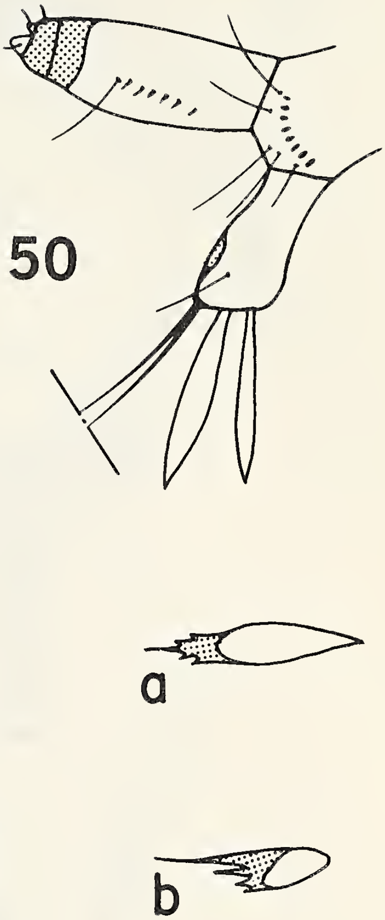

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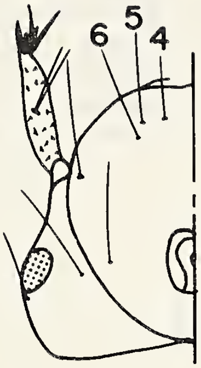

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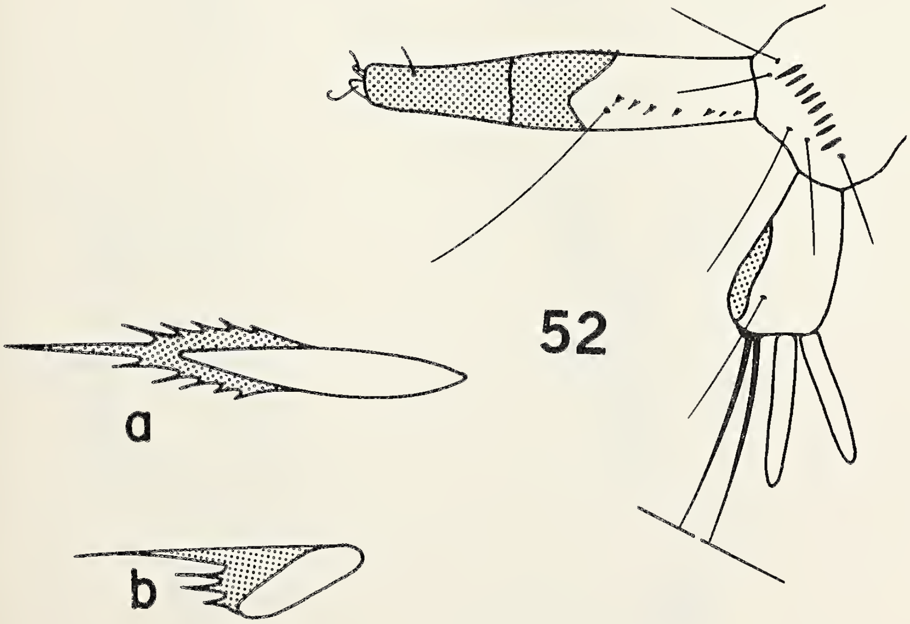

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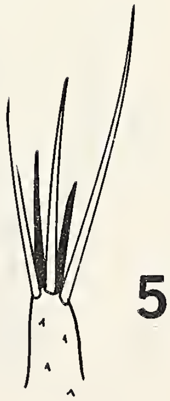

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Plate V

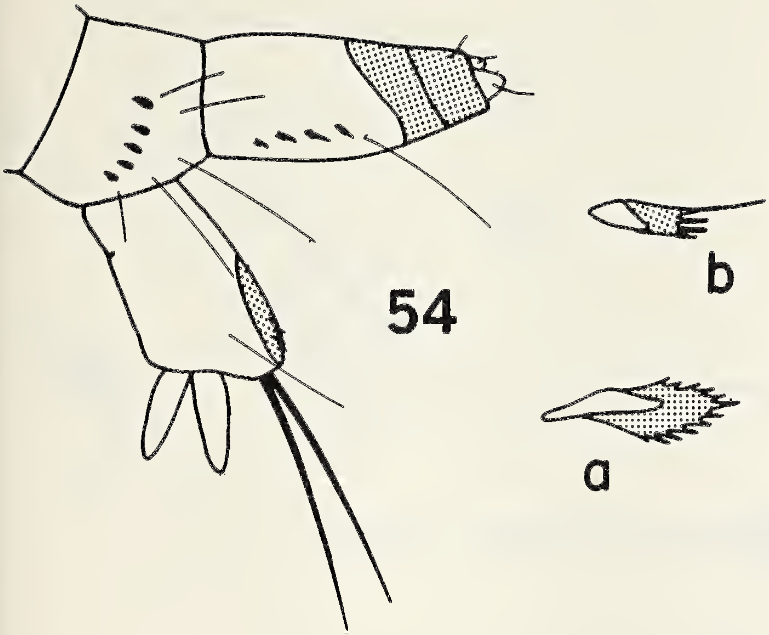
Figures 54–56. Terminal segments of first instar larva, a. comb scale, b. pecten tooth

- 54. *Aedes taeniorhynchus*
- 55. *A. sticticus*
- 56. *A. aegypti*

57–59. Head of first instar larva

- 57. *A. aegypti*
- 58. *A. atropalpus*
- 59. *A. sticticus*

60. *A. sticticus*, antenna



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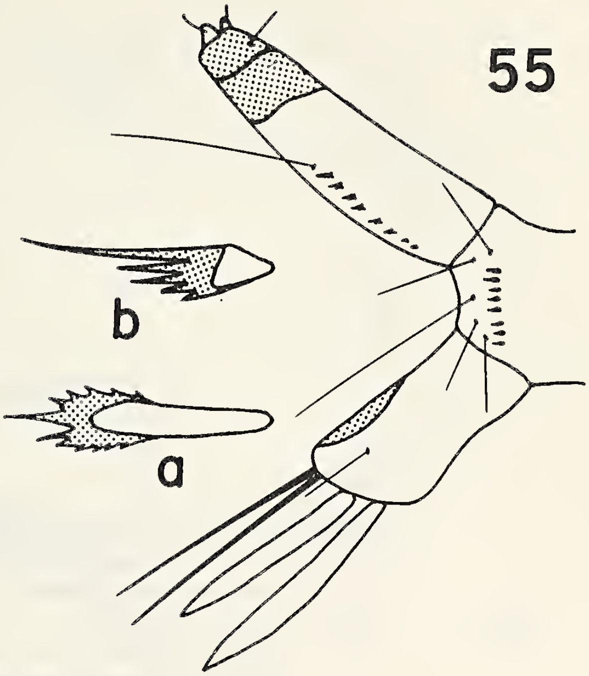

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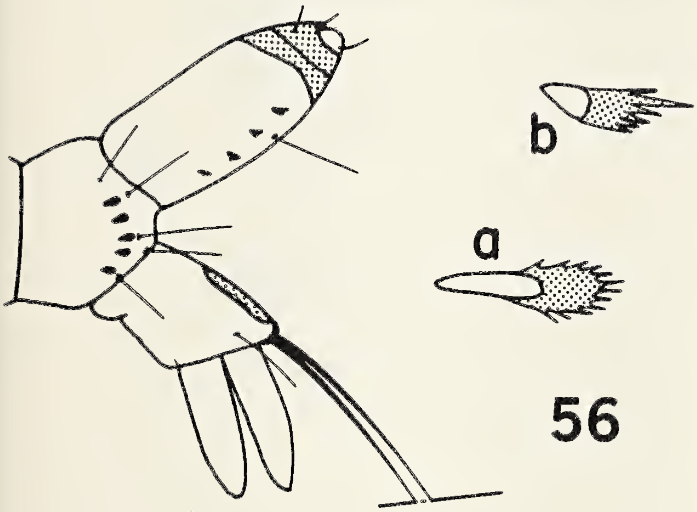

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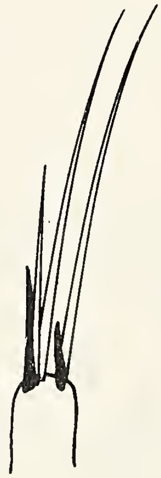

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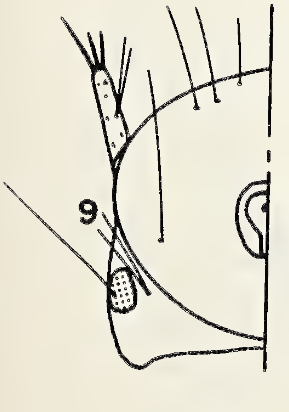

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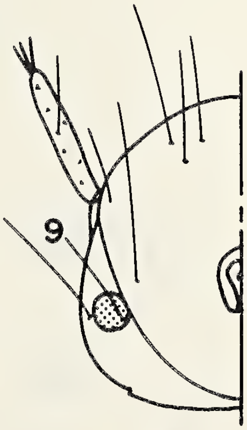

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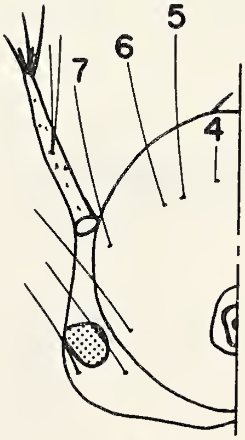

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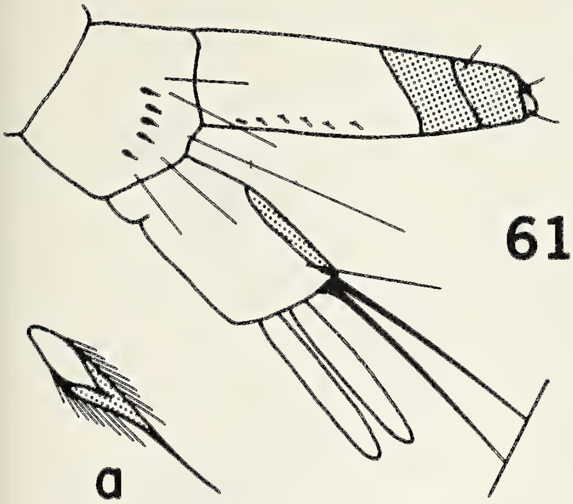
Plate VI

Figures 61–62. Terminal segments of first instar larva, a. comb scale, b. pecten tooth
- 61. *Aedes mitchellae*
- 62. *A. communis*
- 63. *A. flavescens*, head of first instar larva
- 64. *A. cinereus*, antenna of first instar larva
- 65–66. Terminal segments of first instar larva, a. comb scale, b. pecten tooth
- 65. *A. cinereus*
- 66. *A. hexondontus*



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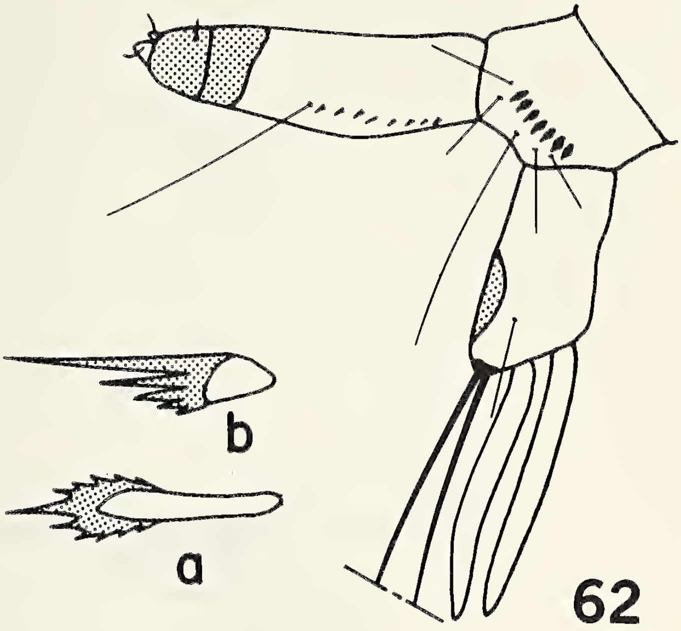

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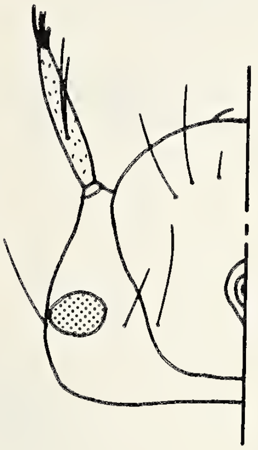

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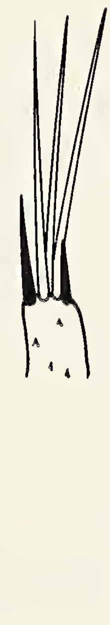

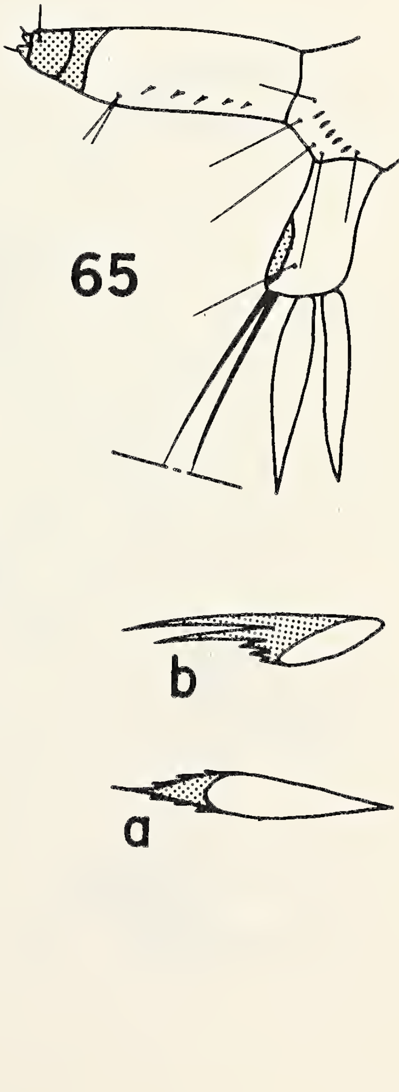

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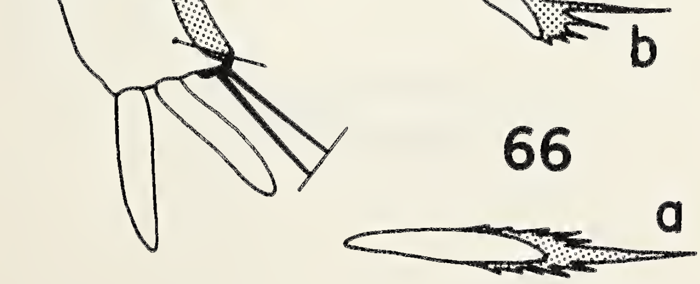

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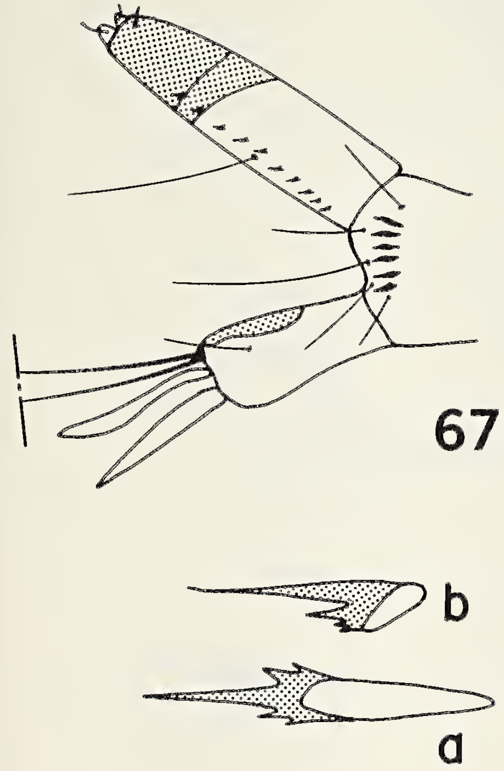
Plate VII

Figures 67–70. Terminal segments of first instar larva, a. comb scale, b. pecten tooth

67. *Aedes trichurus*
68. *A. intrudens*
69. *A. punctor*
70. *A. sollicitans*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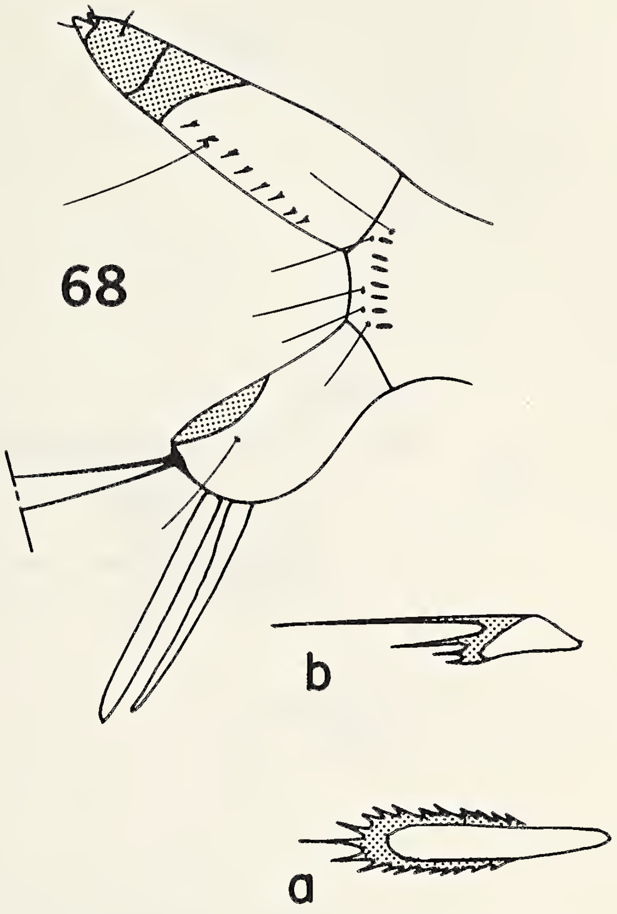
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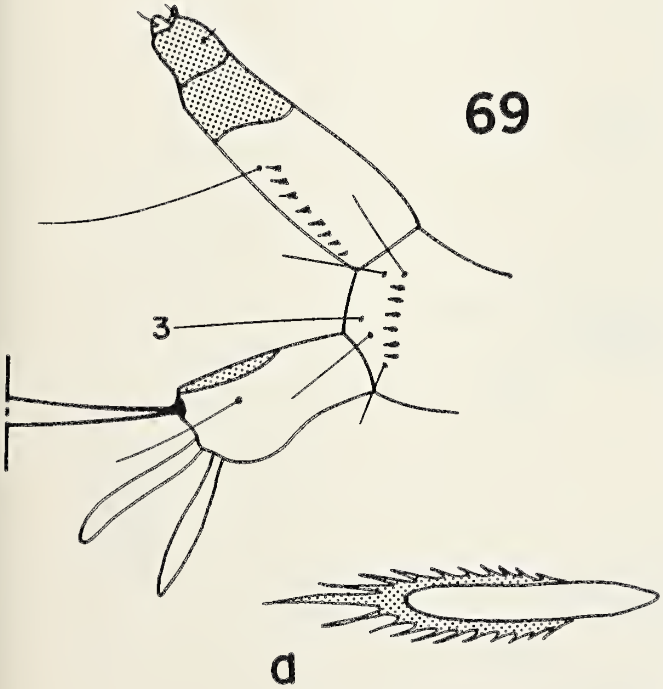
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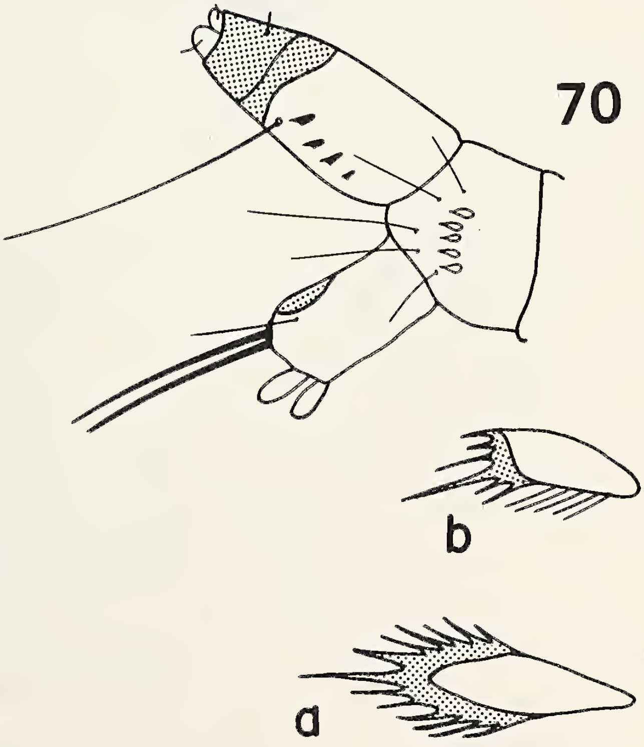
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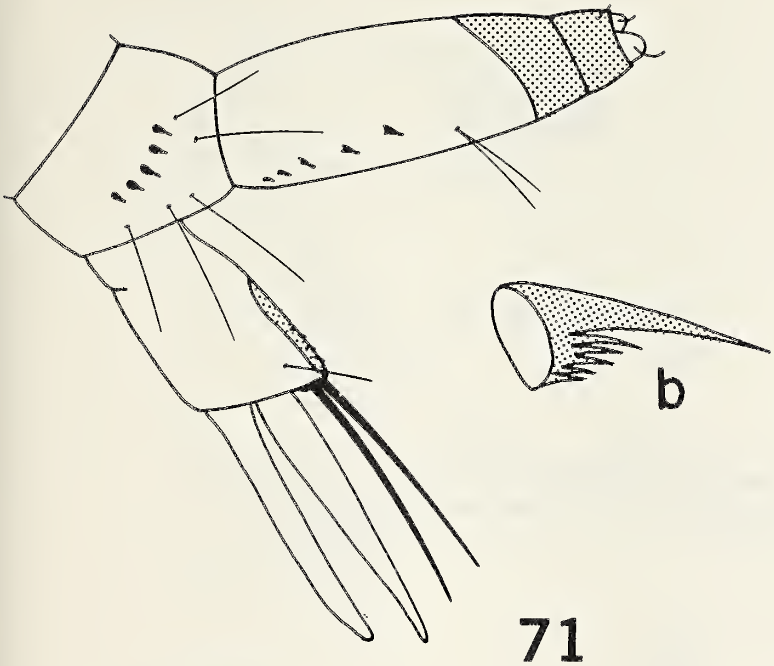
Plate VIII

Figures 71–73. Terminal segments of first instar larva, a. comb scale, b. pecten tooth

71. *Aedes vexans*
72. *A. dorsalis*
73. *A. excrucians*, c. antenna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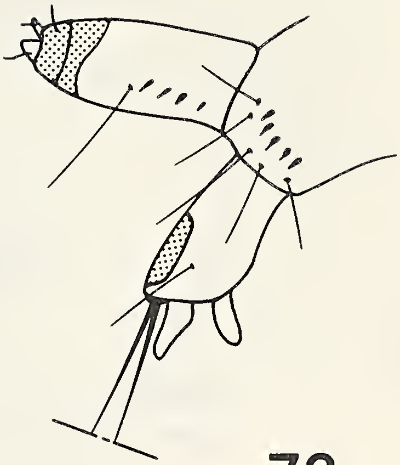
b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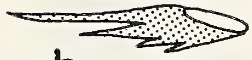
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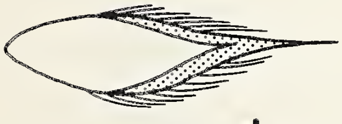
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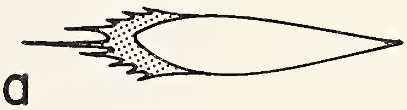
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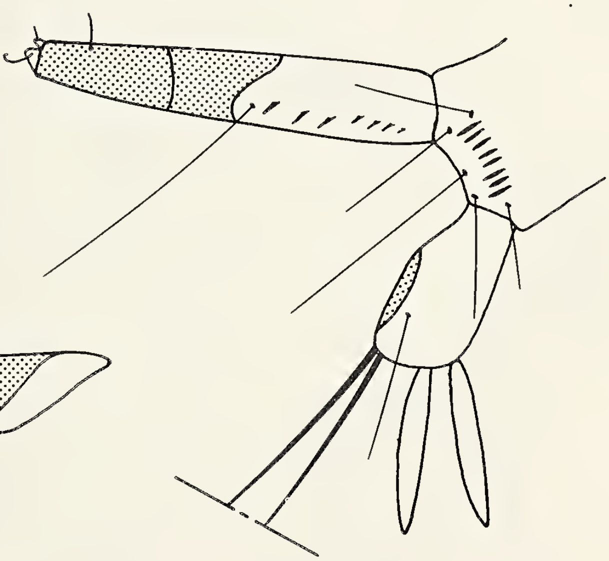
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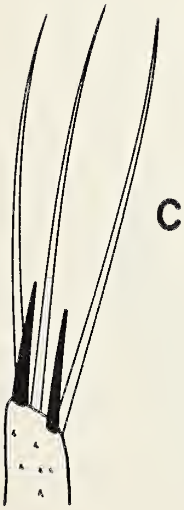
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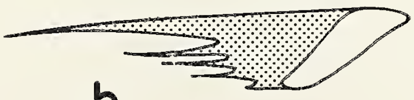
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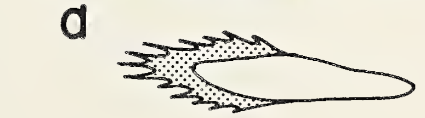
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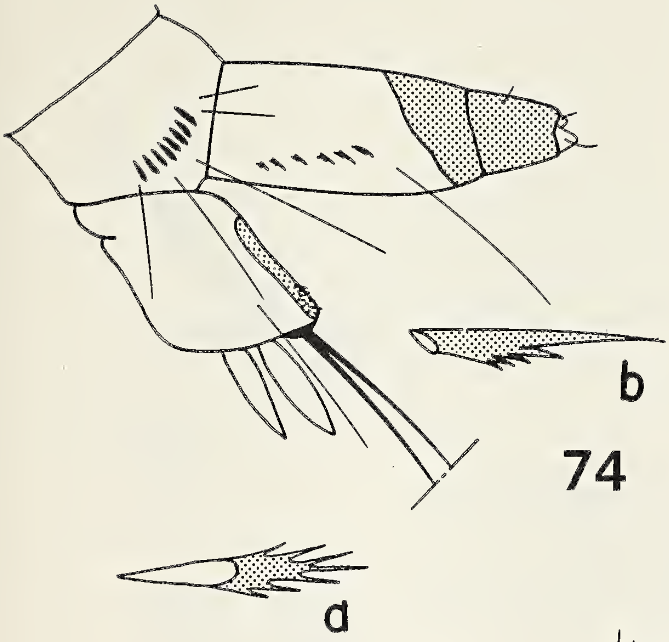
Plate IX

Figures 74, 75, 78. Terminal segments of first instar larva, a. comb scale, b. pecten tooth; 76, 77, 79. Head of first instar larva

74. *Aedes canadensis*
75. *A. stimulans*
76. *A. stimulans*
77. *A. diantaeus*
78. *A. diantaeus*
79. *A. thibaulti*



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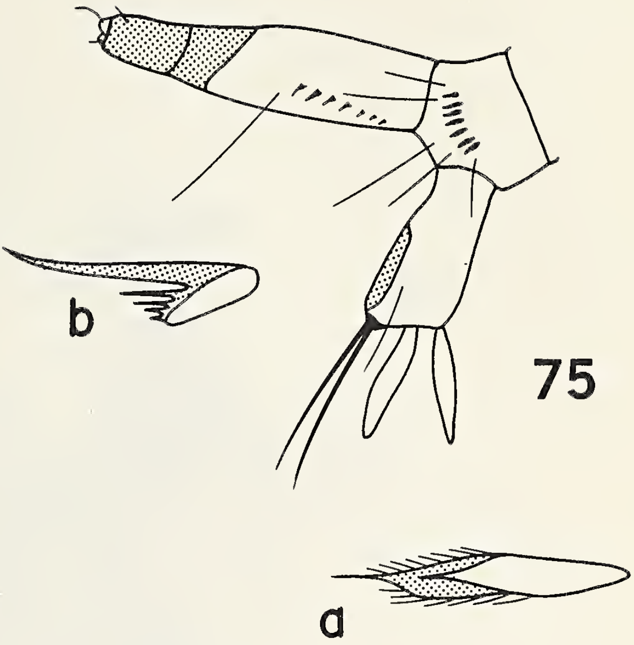

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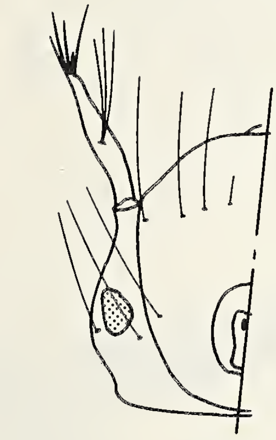

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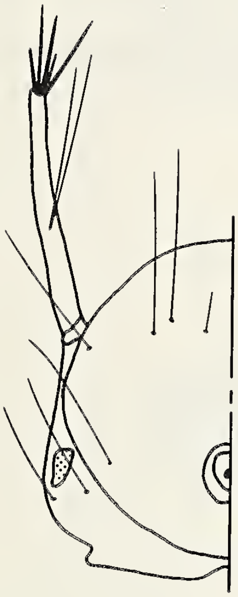

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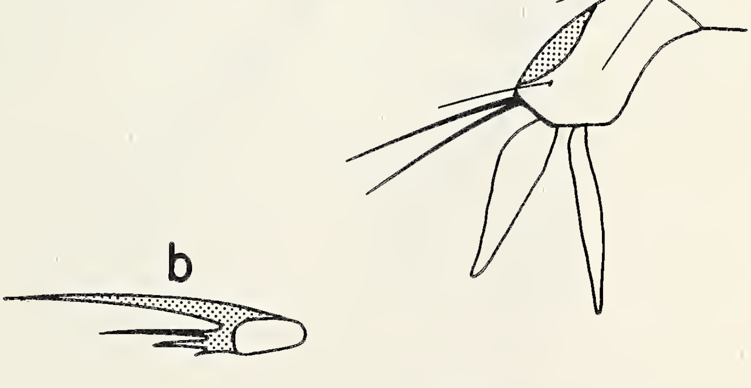

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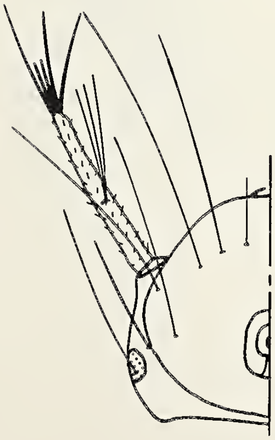

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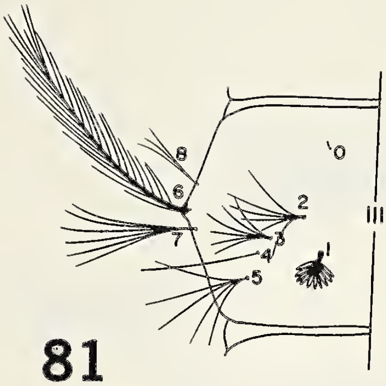
Plate X

Figures 80–81. *Anopheles punctipennis*, fourth instar larva
80. Terminal segments
81. Abdominal segment, dorsal aspect
82–83. *Uranotaenia sapphirina*, fourth instar larva
82. Head
83. Terminal segments
84. *Toxorhynchites rutilus septentrionalis*, terminal segments of fourth instar larva



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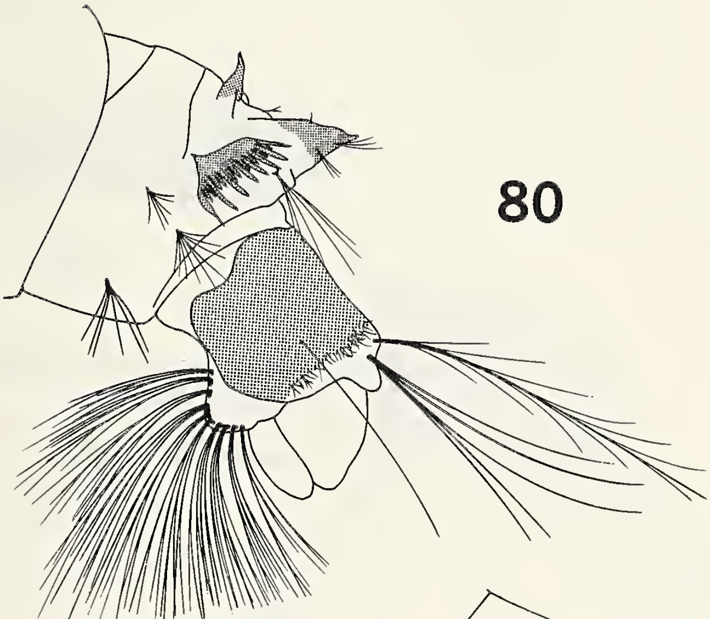

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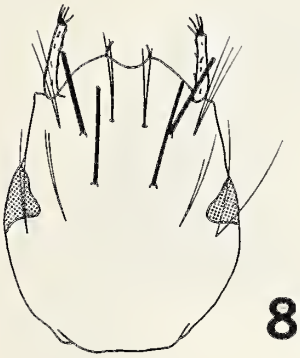

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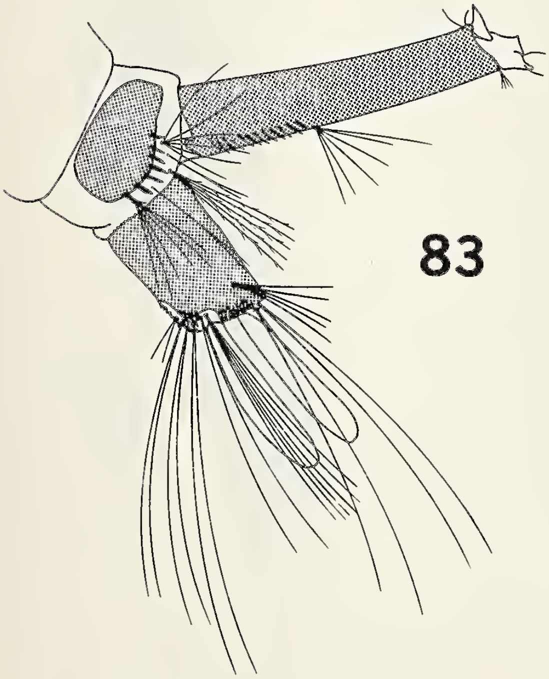

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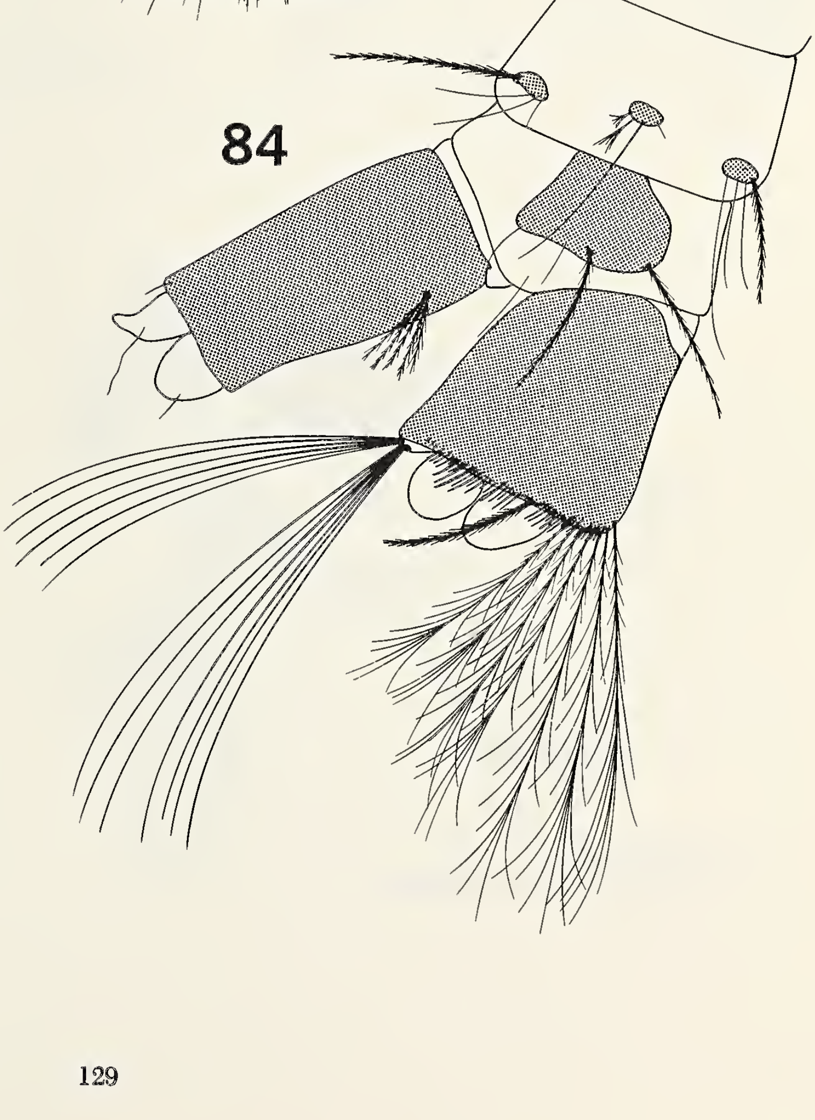


84

Plate XI

Figures 85–87. Terminal segments of fourth instar larva, a. comb scale
85. *Culiseta morsitans dyari*
86. *Psorophora ferox*
87. *Orthopodomyia signifera*

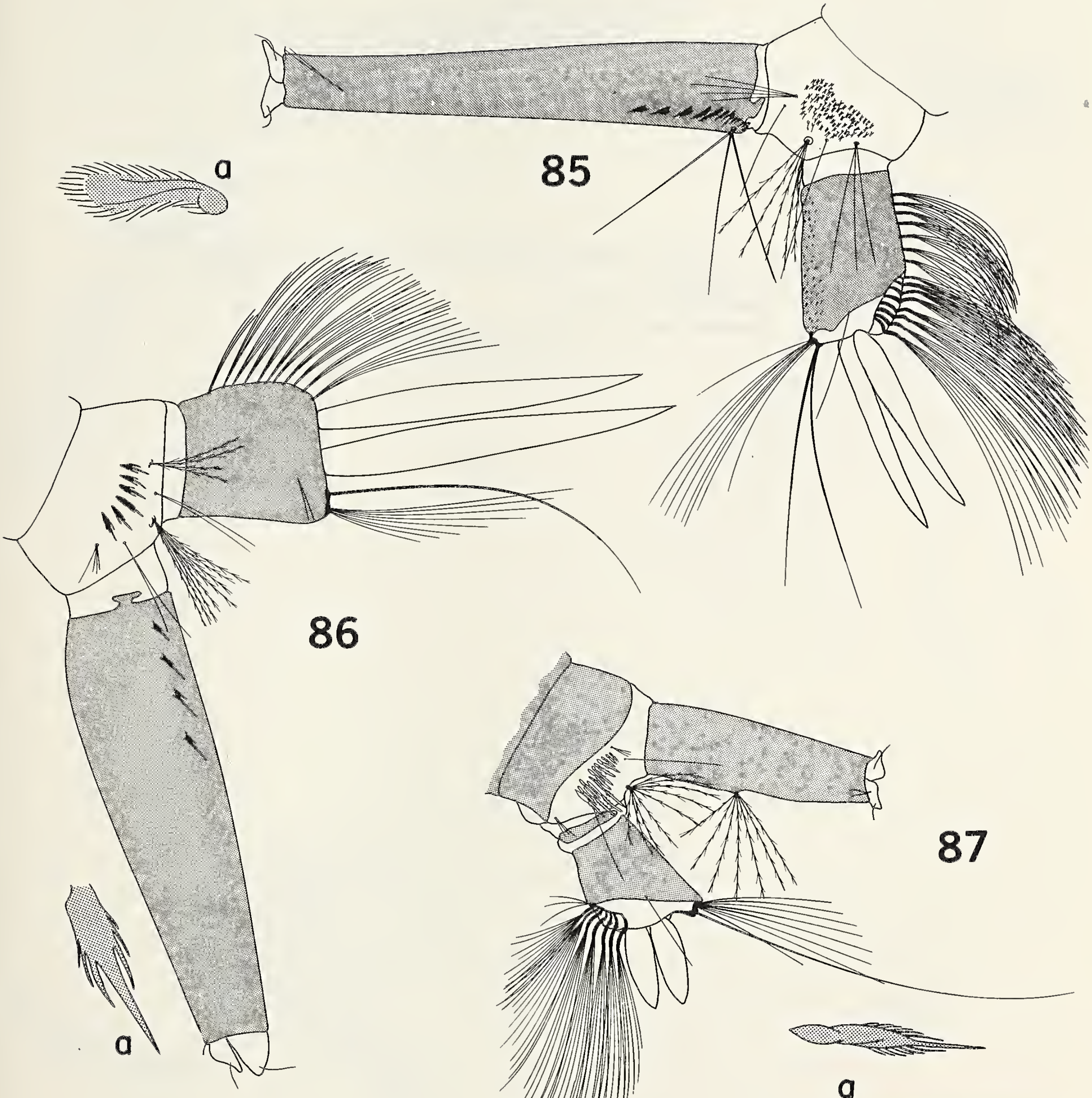
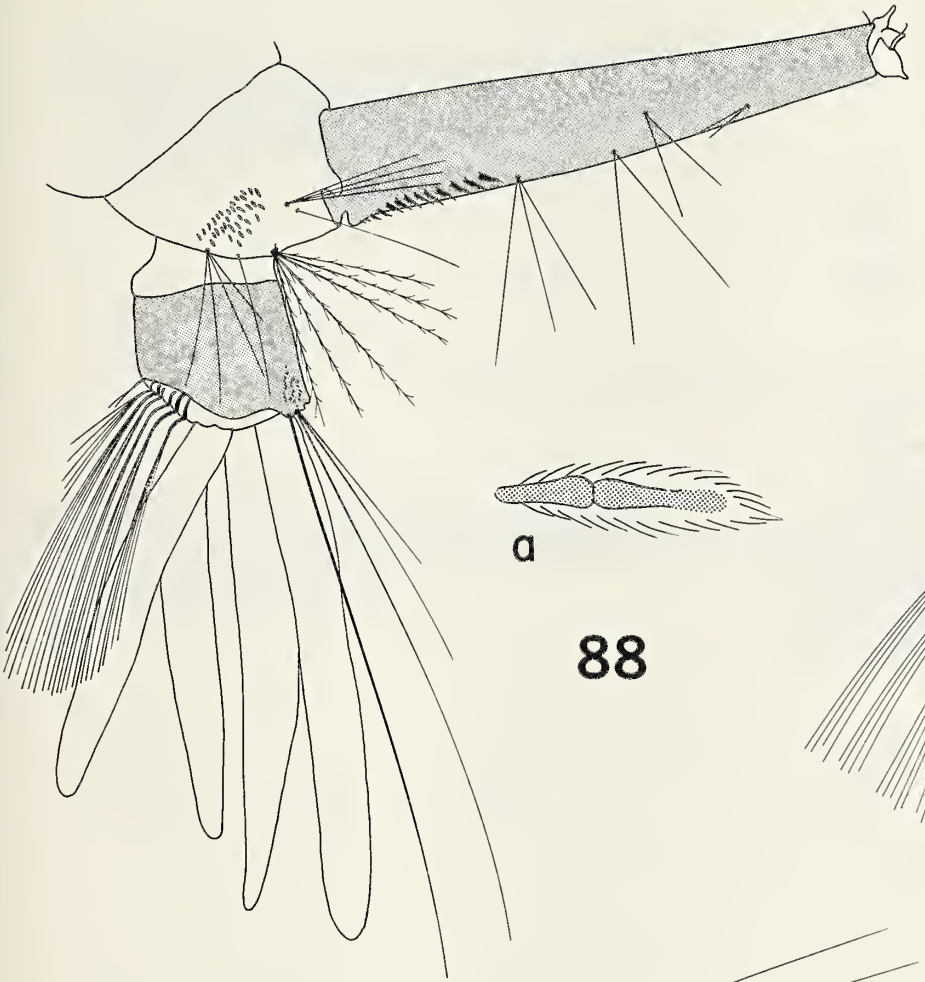

85
a
86
a
87
a

Plate XII

Figures 88–90. Terminal segments of fourth instar larva, a. comb scale
88. *Culex pipiens*
89. *Coquillettidia perturbans*
90. *Wyeomyia smithii*



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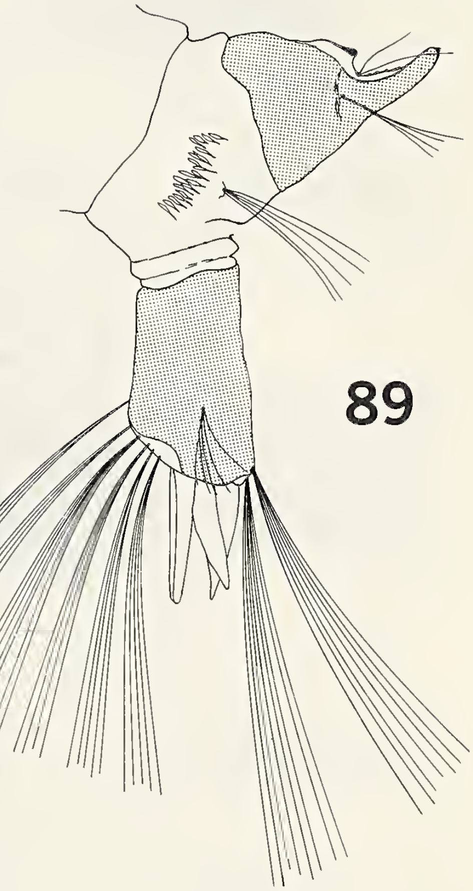

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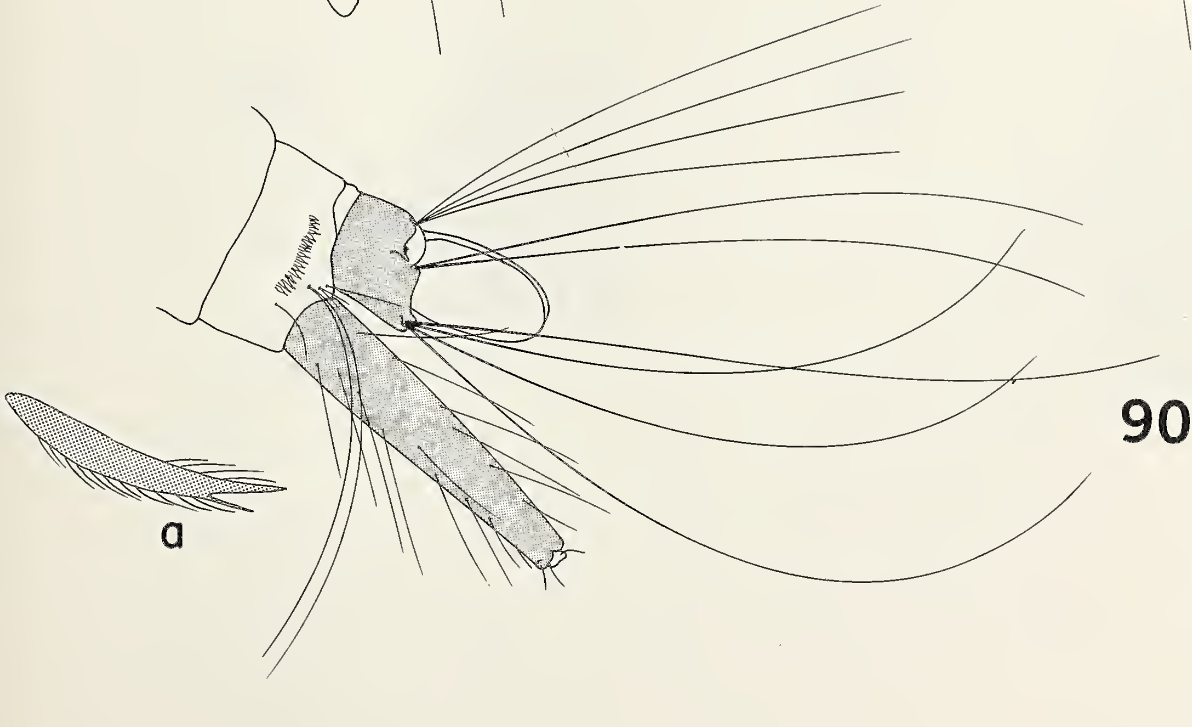

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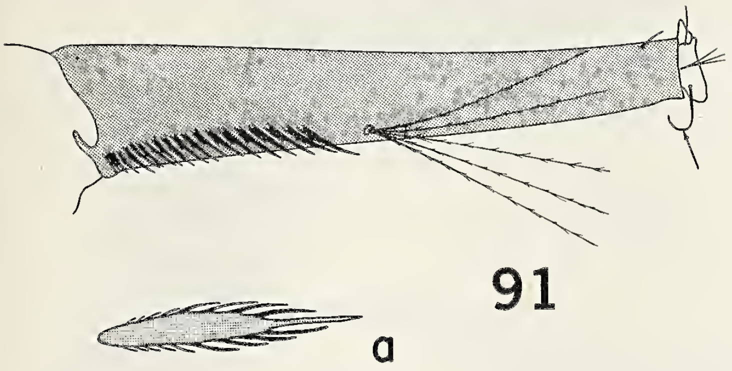
Plate XIII

Figures 91–94. Siphon of fourth instar larva, a. comb scale
91. *Aedes fitchii*
92. A. *atropalpus*
93. A. *excrucians*
94. A. *trichurus*
95–96. Dorsal aspect of abdominal segment V
95. A. *excrucians*
96. A. *fitchii*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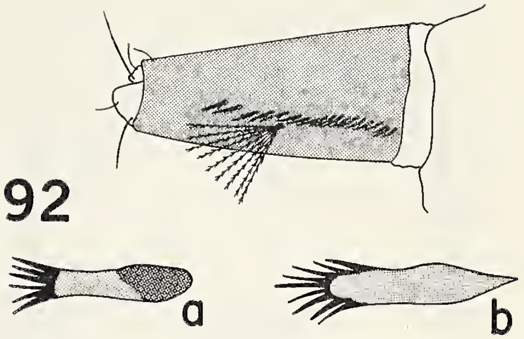
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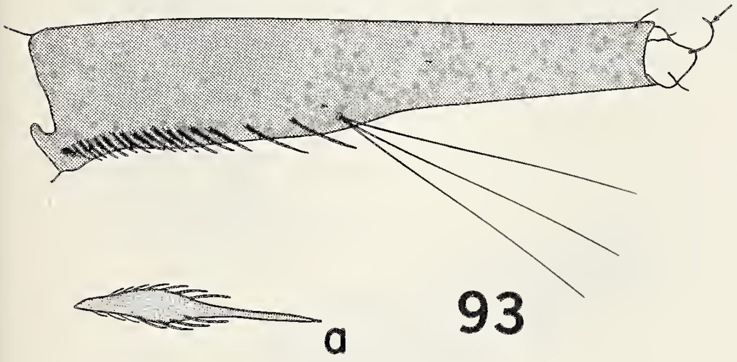
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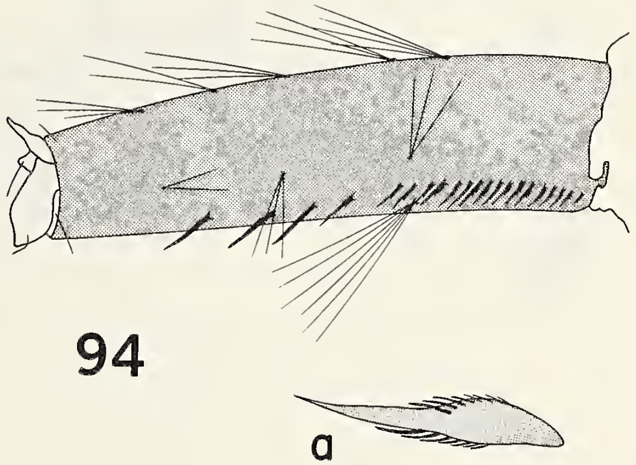
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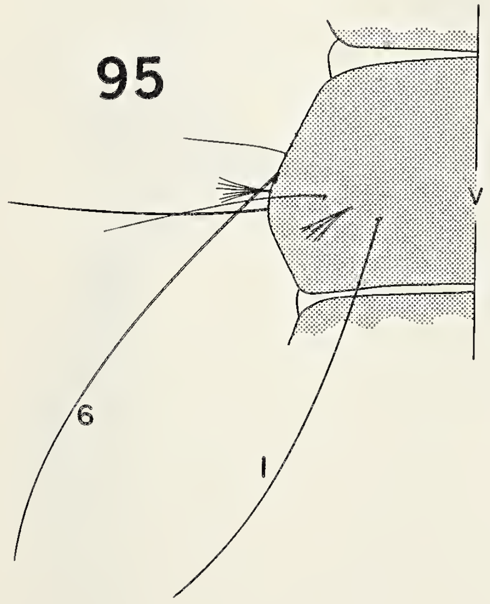
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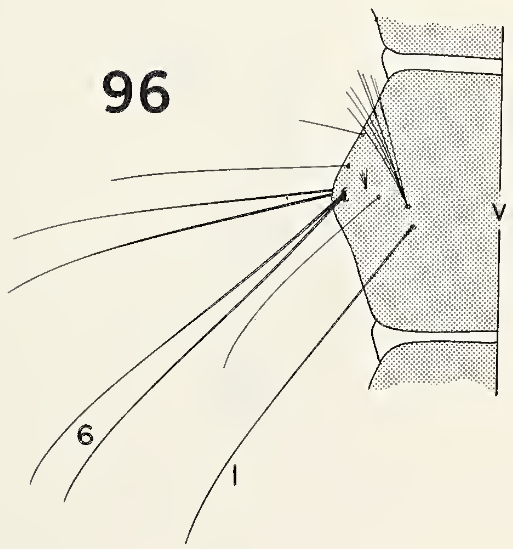
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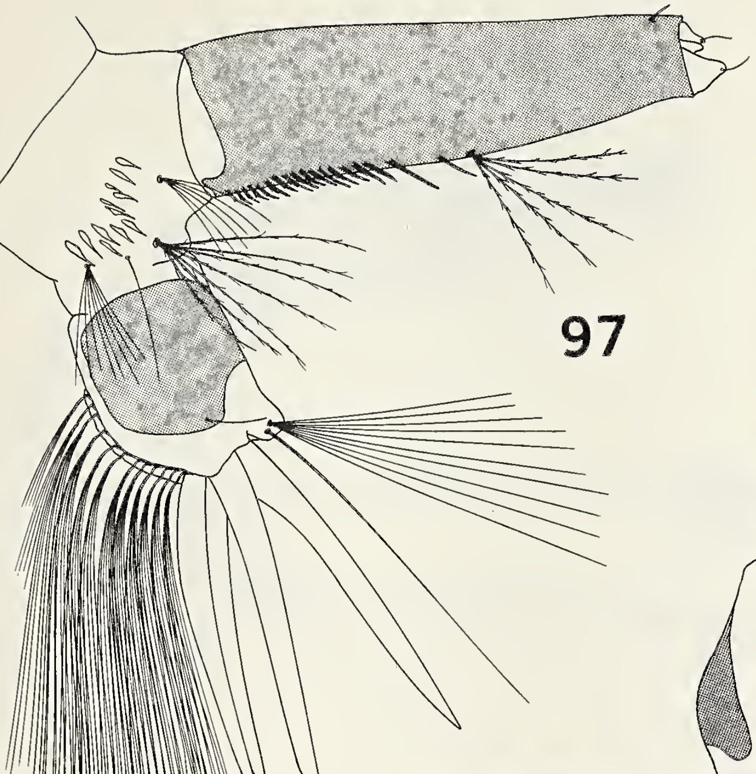
Plate XIV

Figures 97–98. *Aedes diantaeus,* fourth instar larva
97. Terminal segments
98. Head
99. Terminal segments of fourth instar larva of *A. abserratus*
100. Head of fourth instar larva of *A. aurifer*



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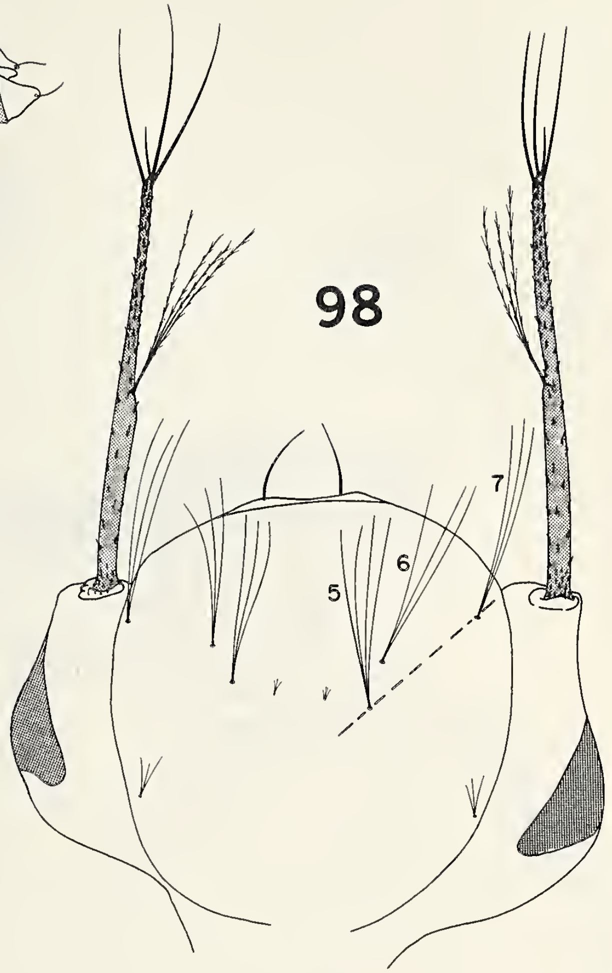

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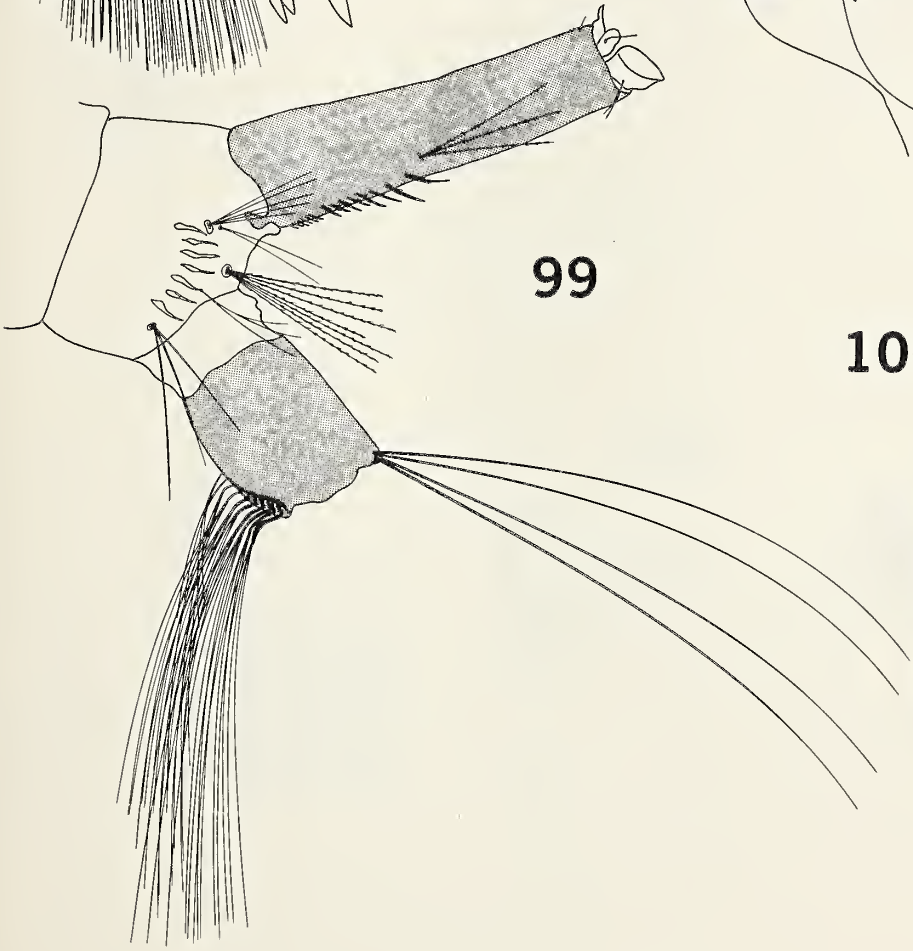

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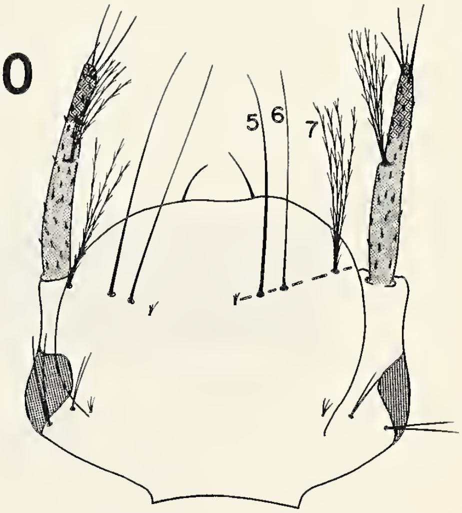

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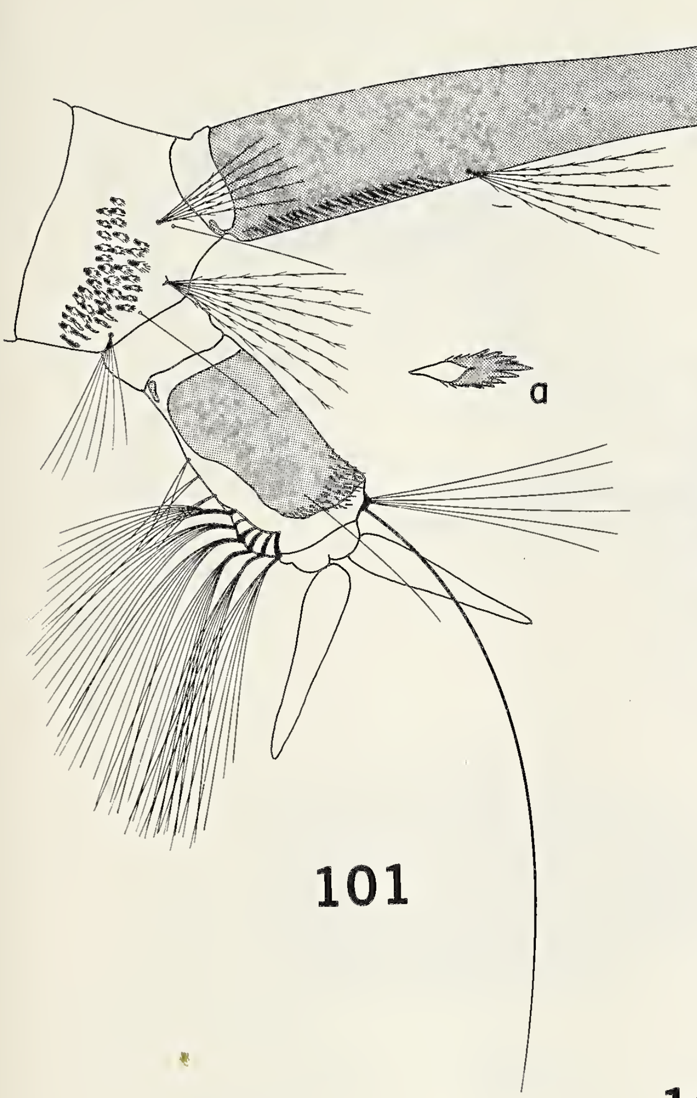
Plate XV

Figures 101–102. Terminal segments of fourth instar larva, a. comb scale, b. pecten tooth

101. *Aedes thibaulti*
102. *A. hendersoni*
103–105. *Aedes triseriatus*, fourth instar larva
103. Abdominal segment
104. Head
105. Siphon



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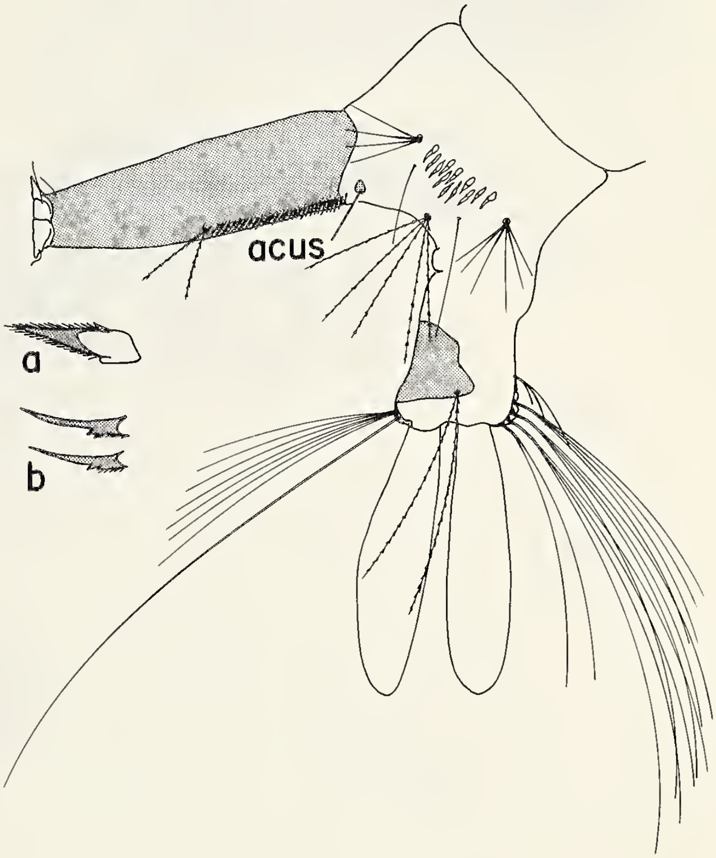

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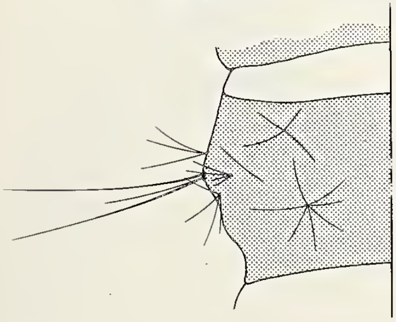

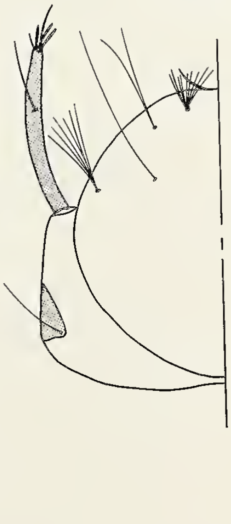

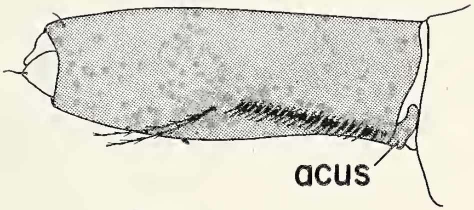

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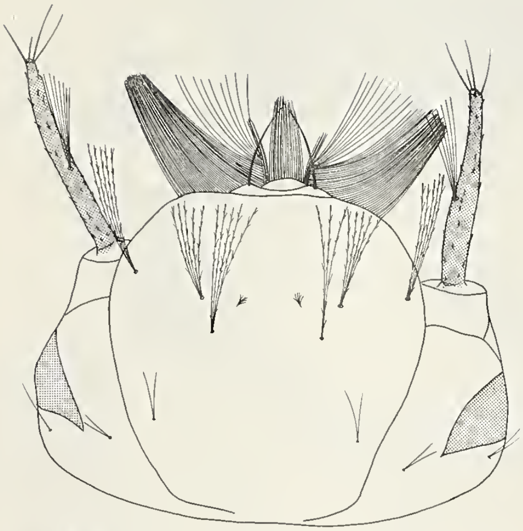
Plate XVI

Figures 106–108. *Aedes canadensis*, fourth instar larva
106. Head
107. Terminal segments, a. comb scale
108. Mesothoracic setae
109–110. *A. cantator*, fourth instar larva
109. Terminal segments, a. comb scale, b. pecten tooth
110. Mesothoracic setae



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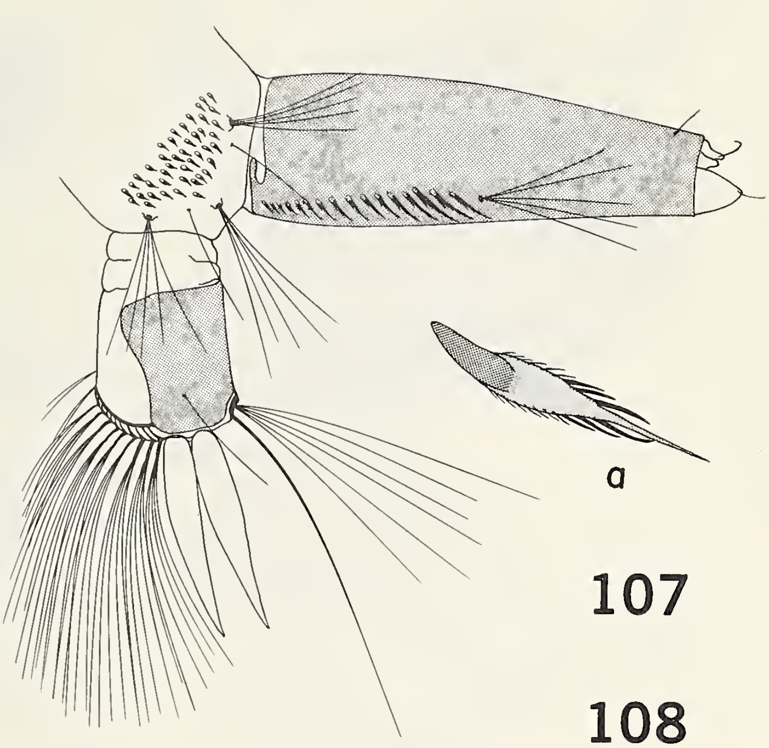

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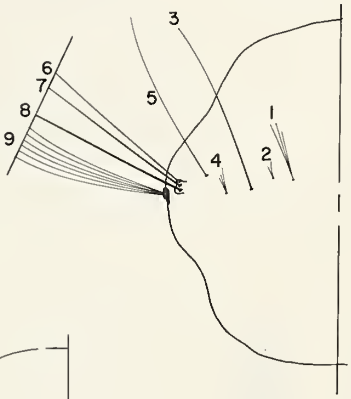

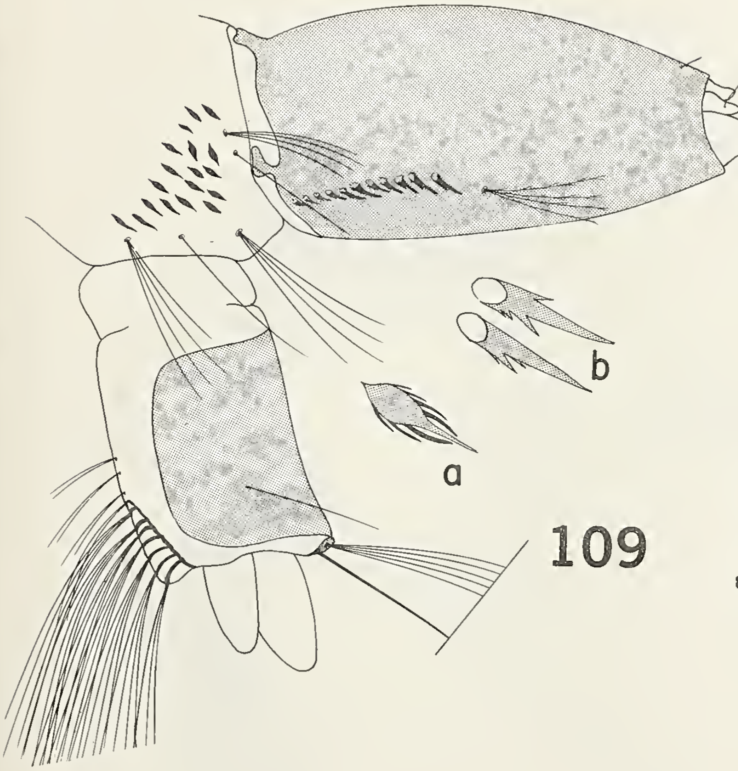

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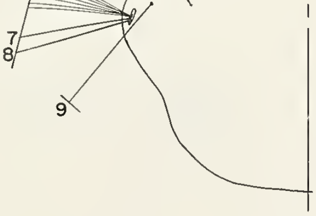

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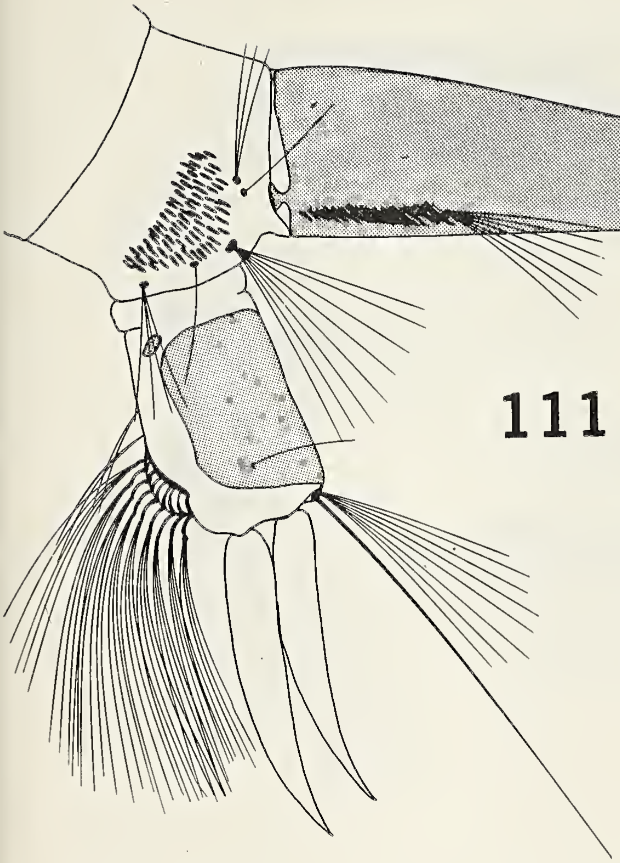
Plate XVII

Figures 111–114. *Aedes communis*, fourth instar larva
111. Terminal segments
112. Head
113. Prothoracic setae
114. Comb scales
115–116. *A. atlanticus*, fourth instar larva
115. Terminal segments
116. Prothoracic setae
117. Comb scales of *A. implicatus*



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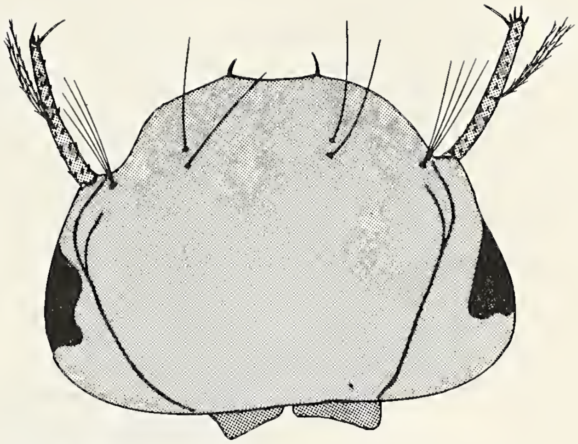

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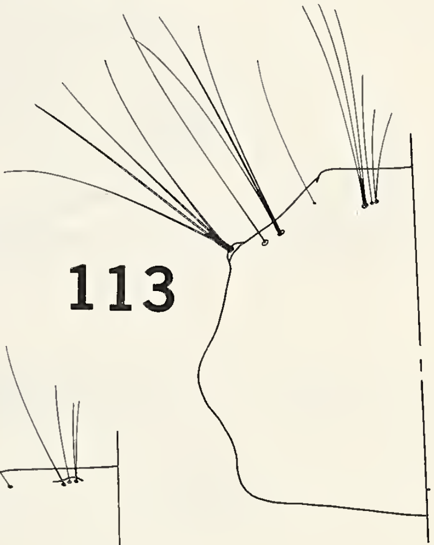

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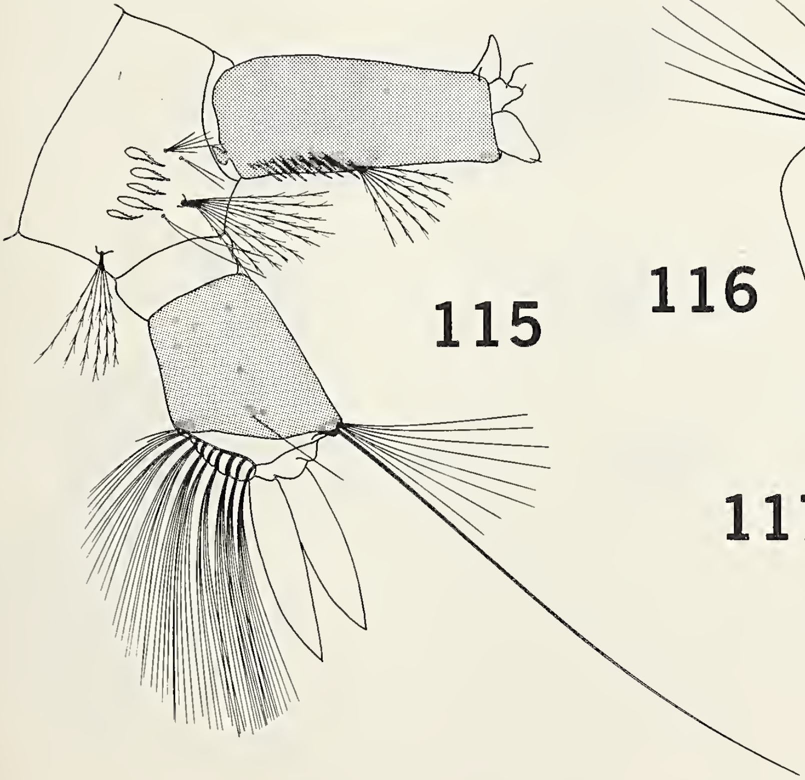

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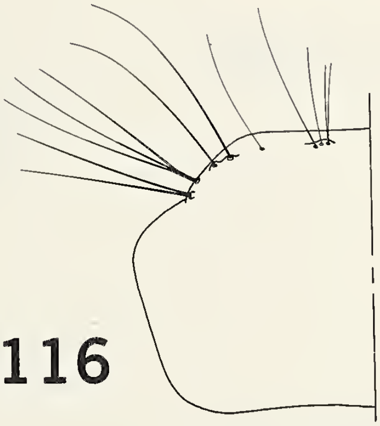

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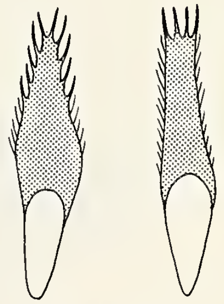

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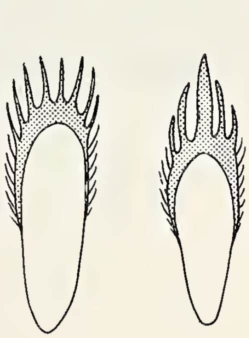
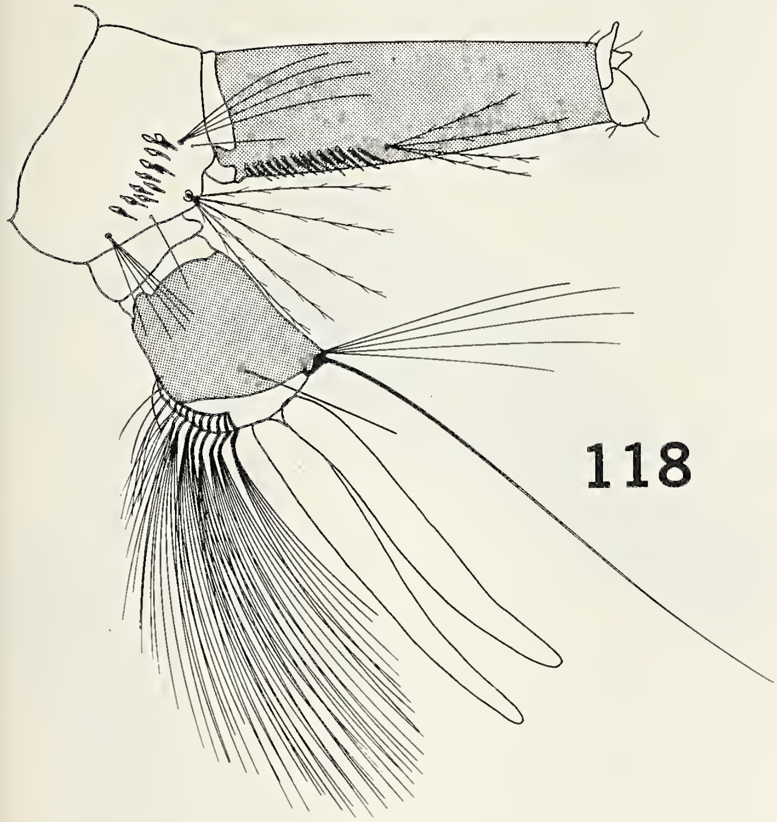


117

Plate XVIII

Figures 118–119. *Aedes punctor*, fourth instar larva
- 118. Terminal segments
- 119. Prothoracic setae
- 120. Comb scales, a. *A. punctor*, b. *A. hexodontus*
- 121. Pecten teeth, a. *A. punctor*, b. *A. hexodontus*
- 122. *A. mitchellae*, terminal segments of fourth instar larva, a. comb scale
- 123. *A. flavescens*, siphon of fourth instar larva



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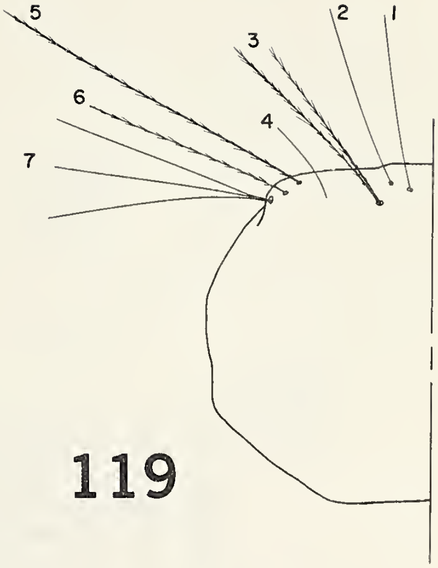

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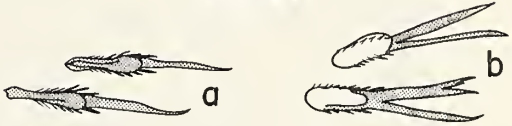

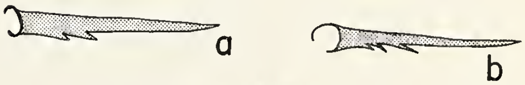

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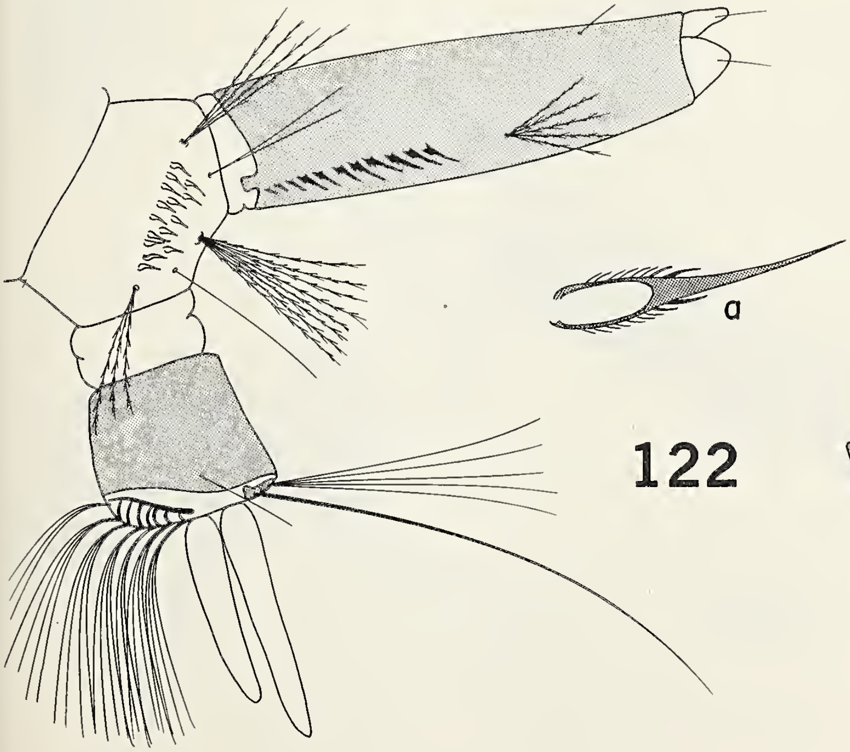

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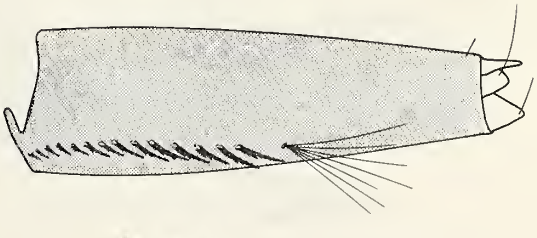
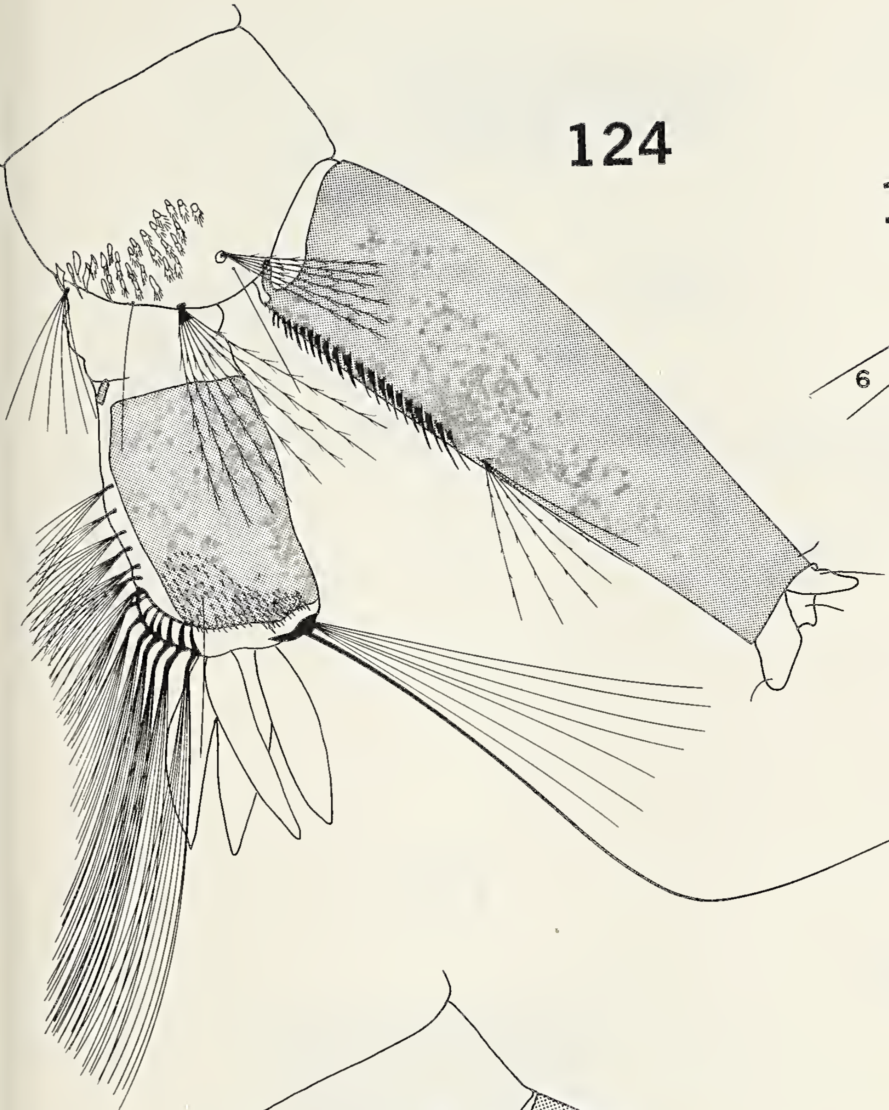


123

Plate XIX

Figures 124–125. *Aedes grossbecki*, fourth instar larva
124. Terminal segments
125. Abdominal segment V
126–127. *A. stimulans*, fourth instar larva
126. Terminal segments, a. comb scale
127. Abdominal segment V



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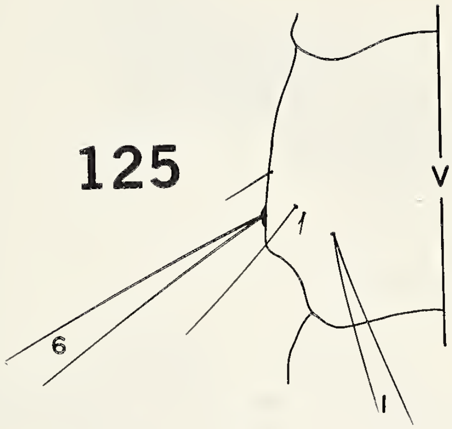

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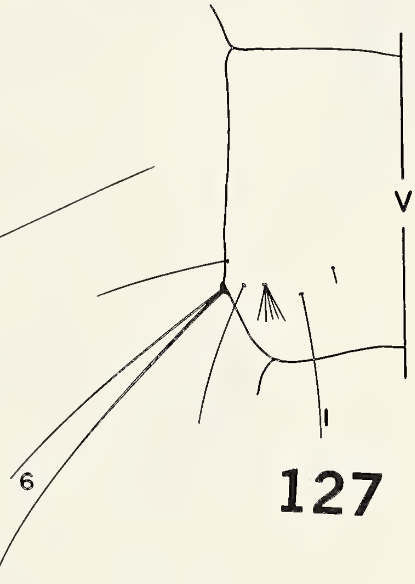

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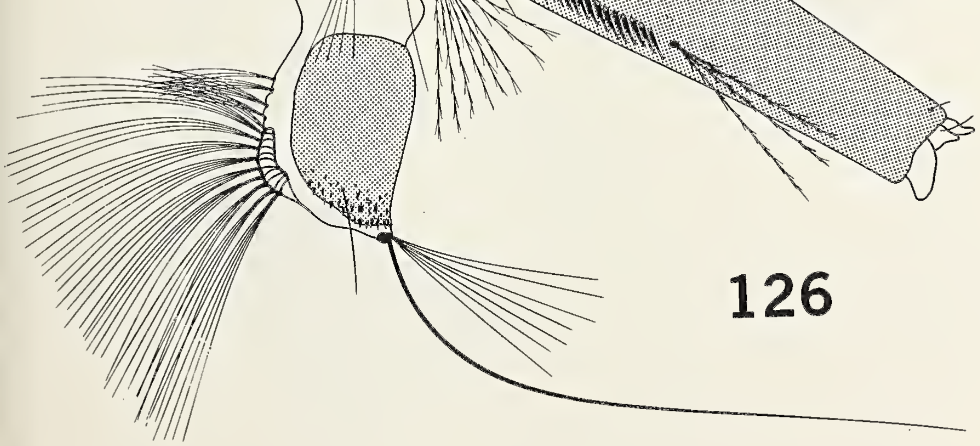

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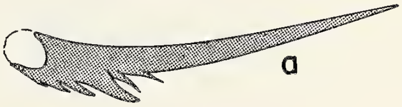

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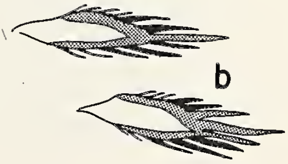
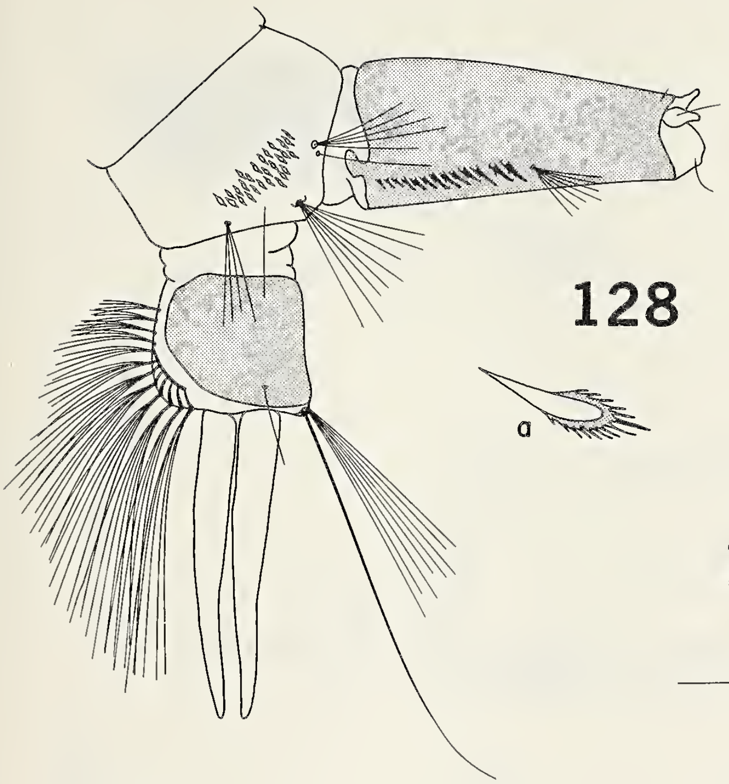


b

Plate XX

Figures 128–131. Terminal segments of fourth instar larva, a. comb scale

- 128. *Aedes sticticus*
- 129. *A. intrudens*
- 130. *A. dorsalis*
- 131. *A. decticus*



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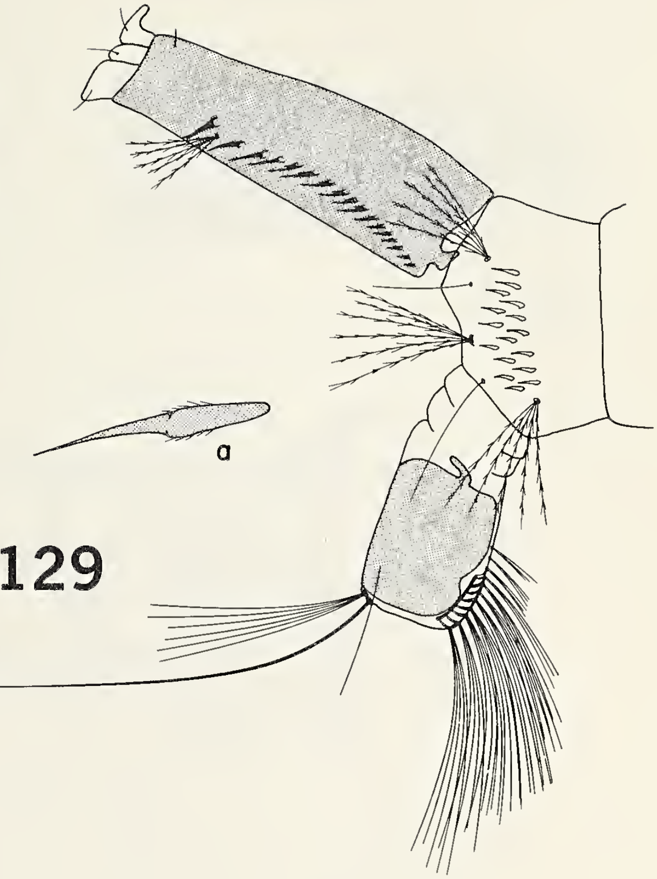

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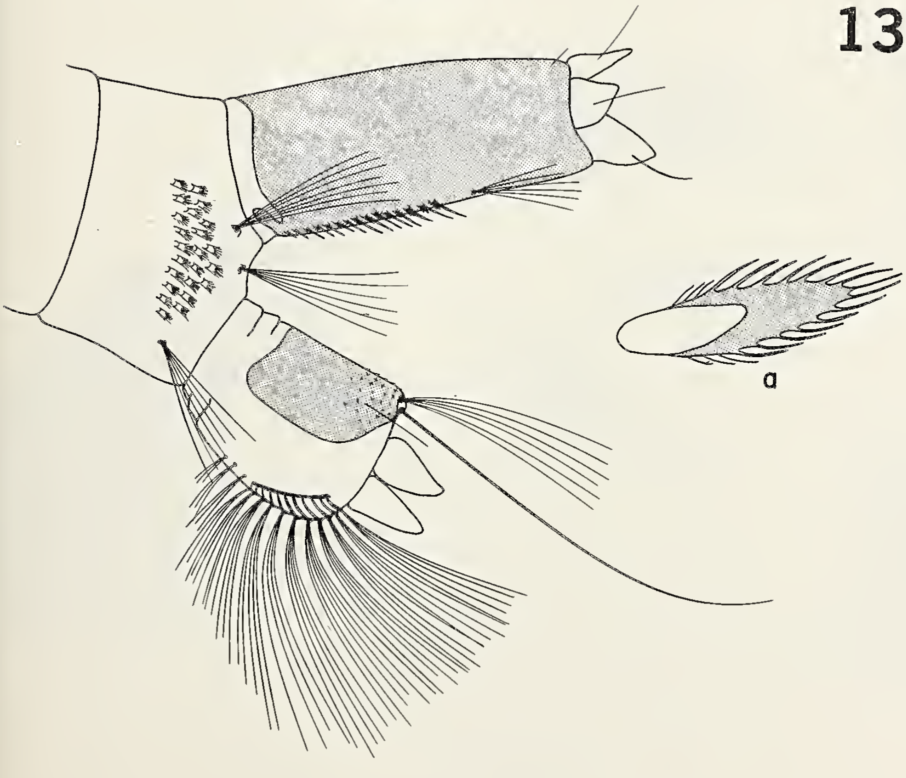

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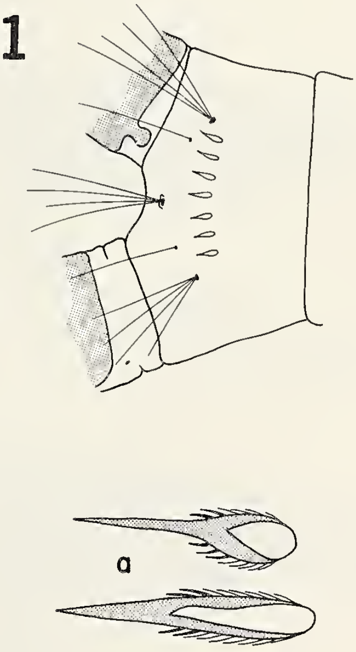


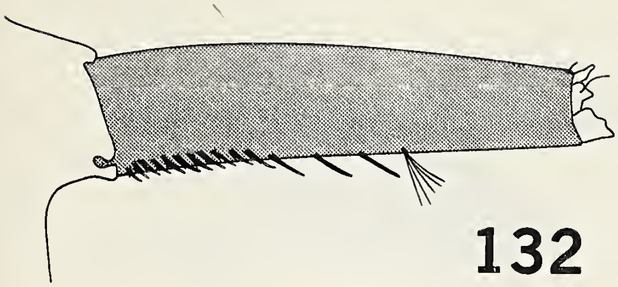
Plate XXI

Figures 132–133. Siphon of fourth instar larva
- 132. *Aedes cinereus*
- 133. *A. vexans*

134–135. Head of fourth instar larva
- 134. *A. cinereus*
- 135. *A. vexans*

136. *A. riparius*, terminal segments of fourth instar larva, a. comb scale.

137–138. Siphon of fourth instar larva, a. comb scale
- 137. *A. spencerii*
- 138. *A. barri*



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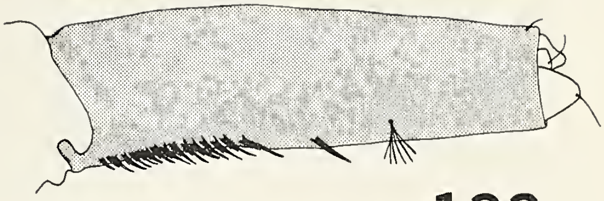

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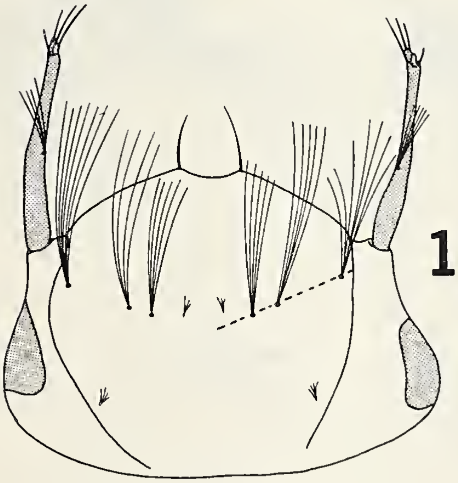

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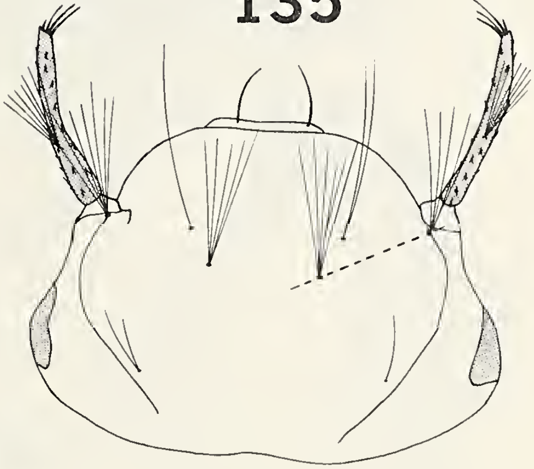

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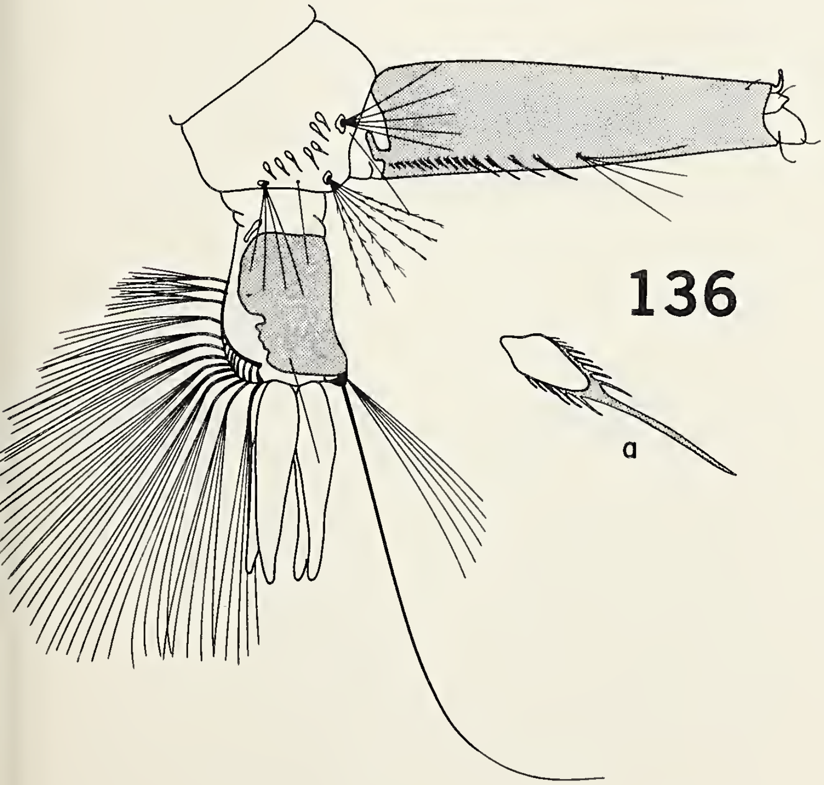

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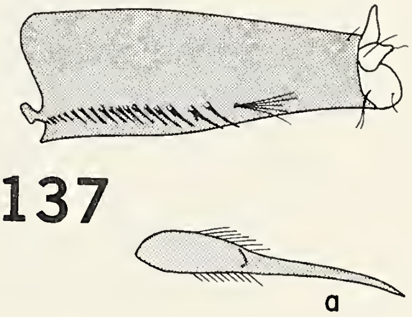

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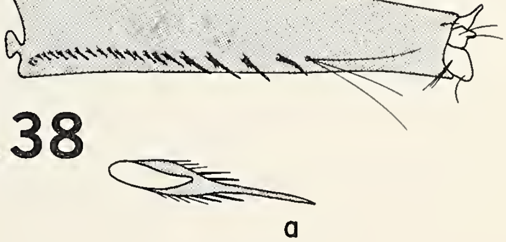

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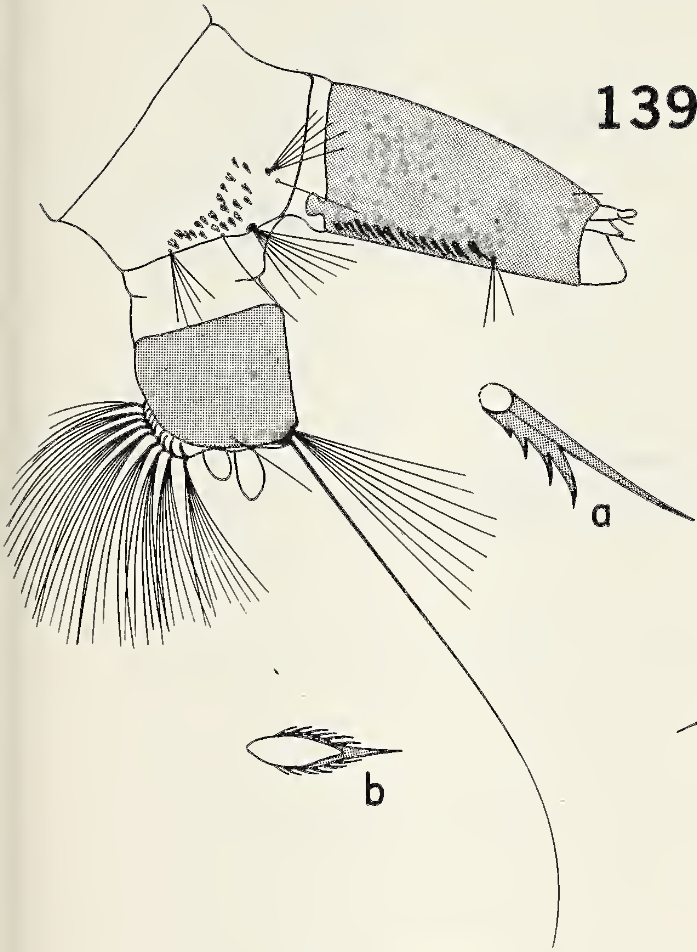
Plate XXII

Figures 139–141. Terminal segments of fourth instar larva, a. comb scale, b. pecten tooth

139. *Aedes sollicitans*
140. *A. taeniorhynchus*
141. *A. trivittatus*



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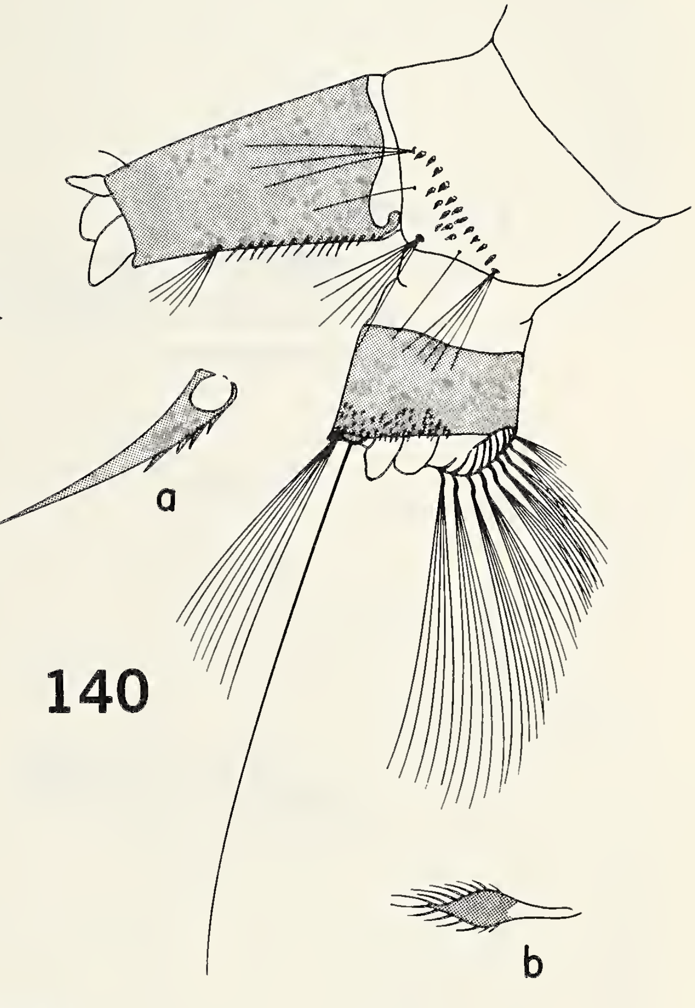

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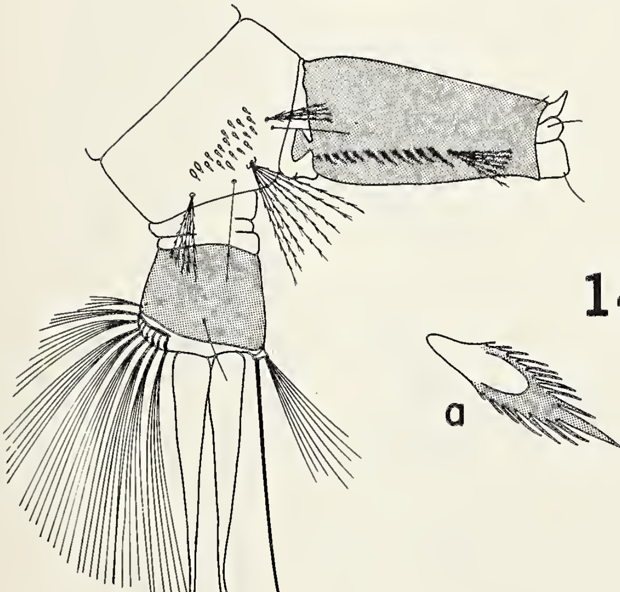

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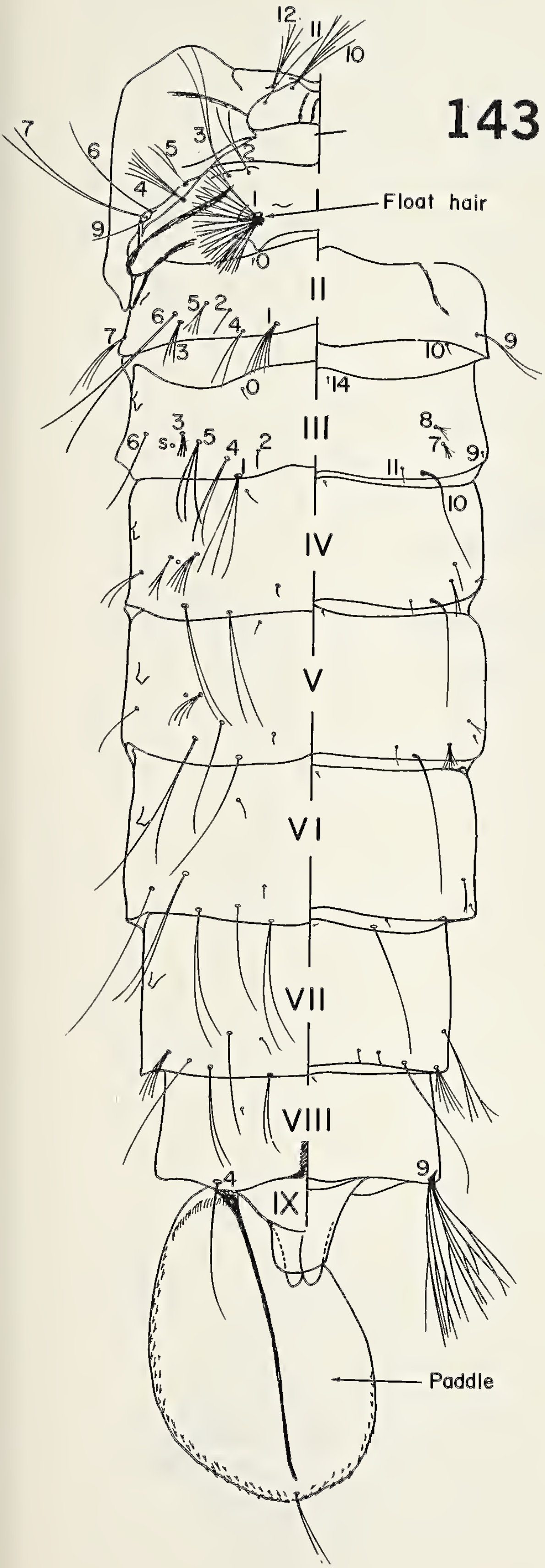
Plate XXIII

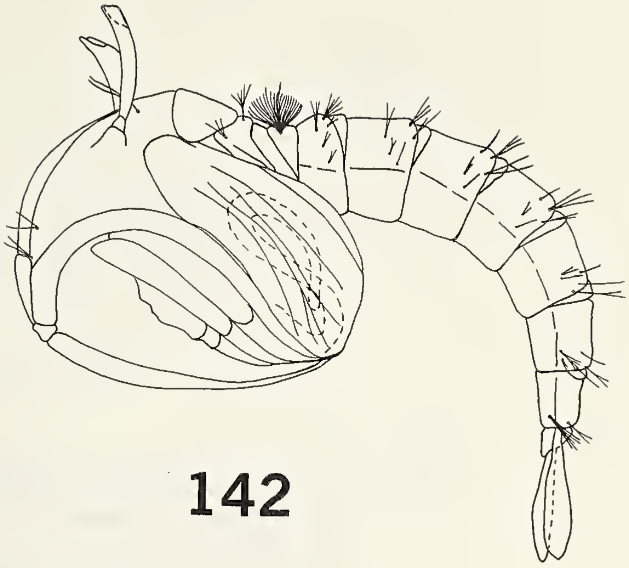
Figures 142. Generalized mosquito pupa, lateral aspect
143–144. *Aedes fitchii*, pupa, showing setal signatures
143. Metanotum and abdomen
144. Cephalothorax

143



12
11
10
7
6
5
3
2
4
1
9
Float hair
II
III
IV
V
VI
VII
VIII
IX
14
s.
8
Paddle

142



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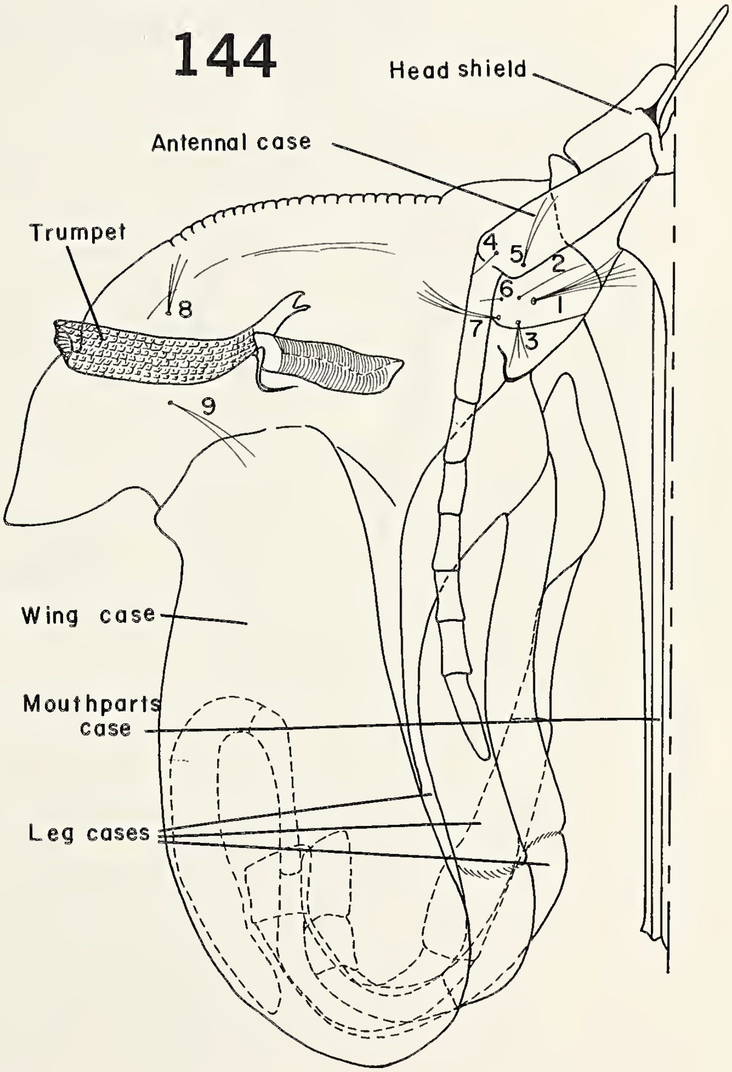
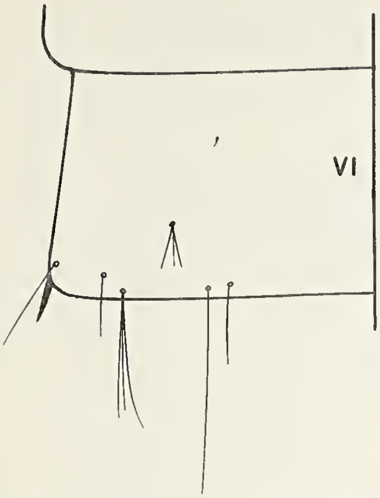


Head shield
Antennal case
Trumpet
Wing case
Mouthparts case
Leg cases

Plate XXIV

Figures 145–146. *Anopheles punctipennis*, pupa
- 145. Abdominal segment VI
- 146. Paddle
- 147. *Wyeomyia smithii*, float hair of pupa
- 148–149. *Toxorhynchites rutilus septentrionalis*, pupa
- 148. Abdominal segment VI
- 149. Paddle
- 150. *Coquillettidia perturbans*, metathorax of pupa



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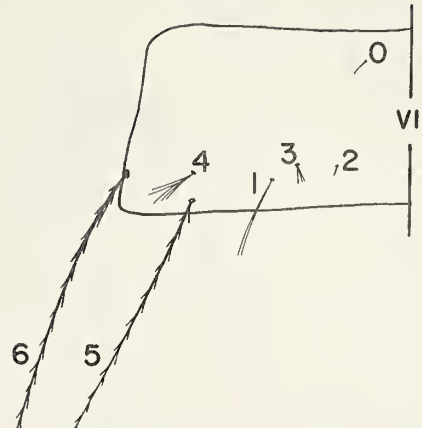

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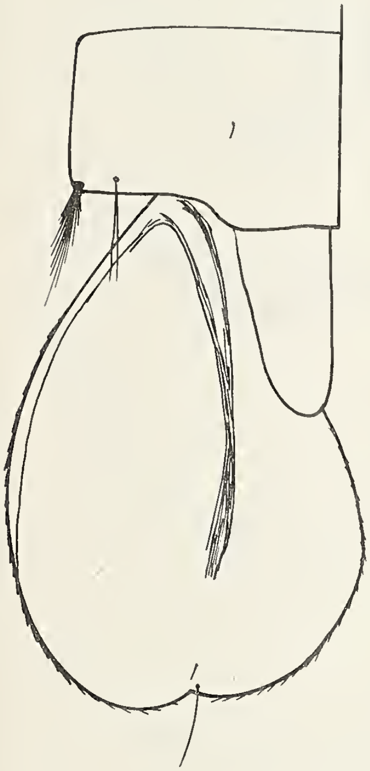

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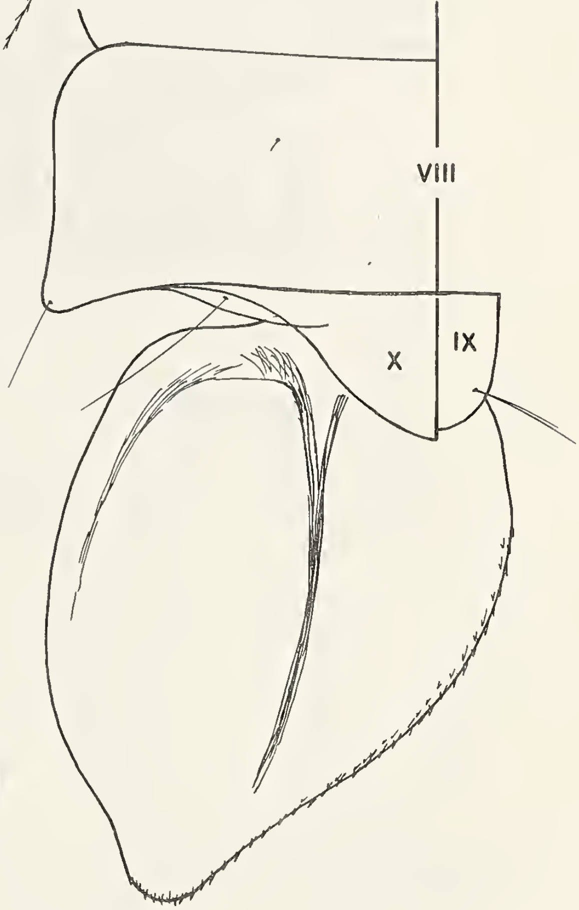

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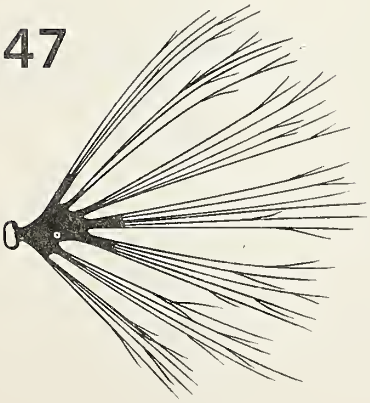

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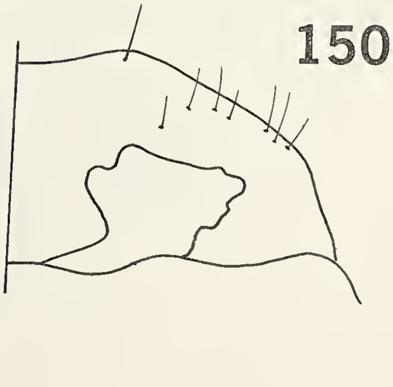
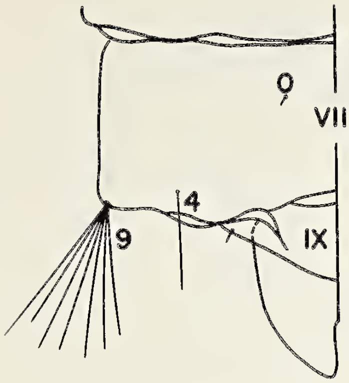


Plate XXV

Figures 151. *Culiseta inornata,* eighth abdominal segment of pupa
152. Distal margin of pupal paddle, a. *Culiseta melanura,* b. *C. incidens,* c. *C. silvestris minnesotae*
153–154. Pupal paddle
153. *Uranotaenia sapphirina*
154. *Psorophora confinnis*
155–156. Abdominal segment IV of pupa
155. *Psorophora ferox*
156. *C. silvestris minnesotae*



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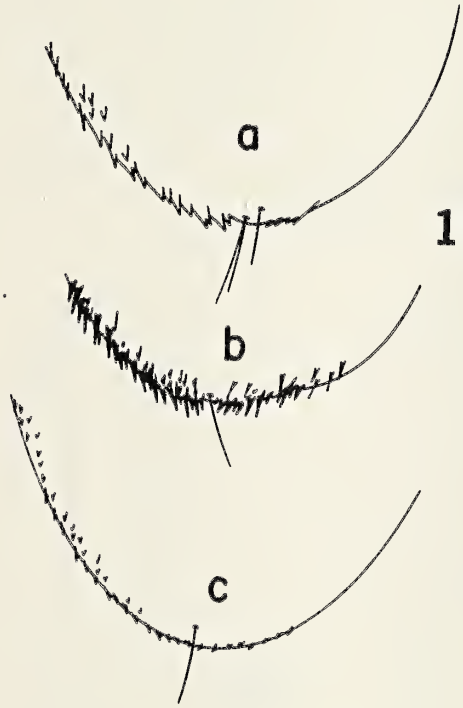

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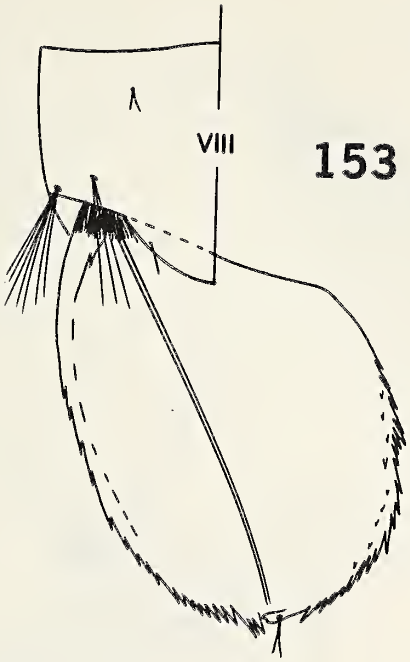

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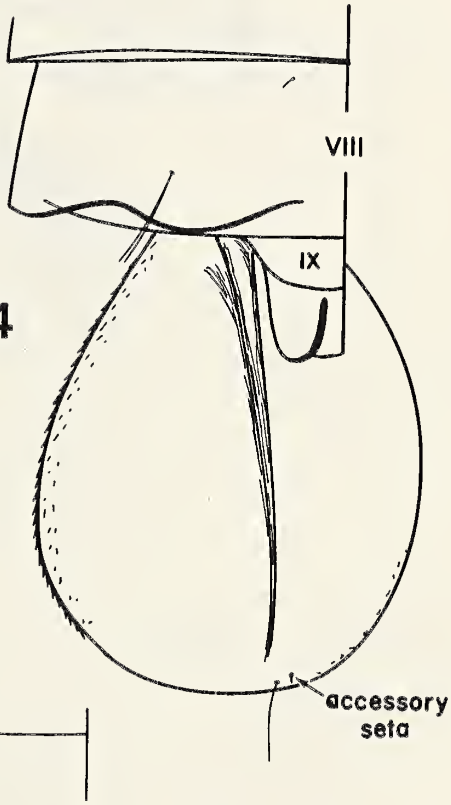

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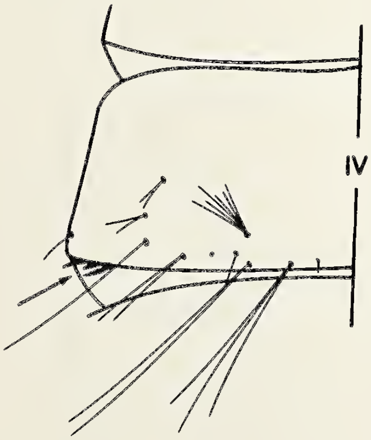

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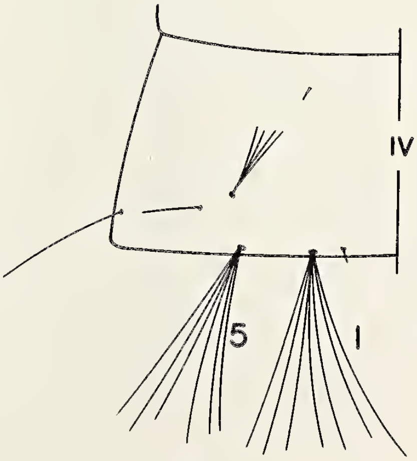

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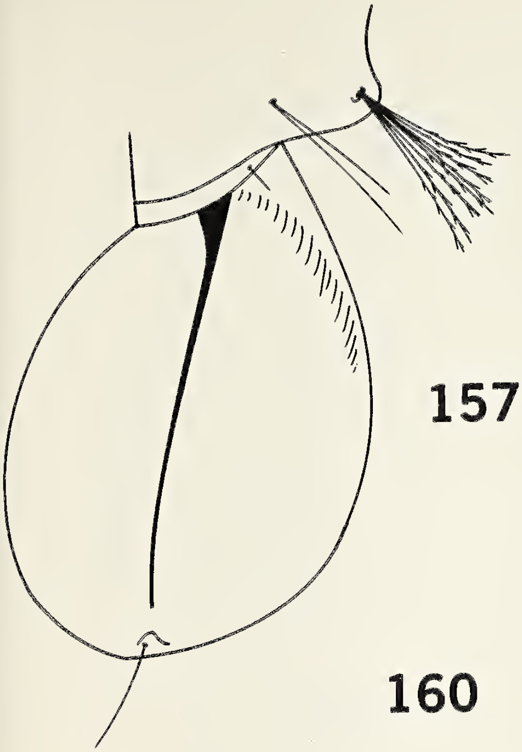
Plate XXVI

Figures 157–164. Pupal paddles
157. *Culex restuans*
158. *Wyeomyia smithii*
159. *Coquillettidia perturbans*
160. *Orthopodomyia signifera*
161. *Aedes trivittatus*
162. *A. vexans*
163. *A atropalpus*
164. *A. cantator*



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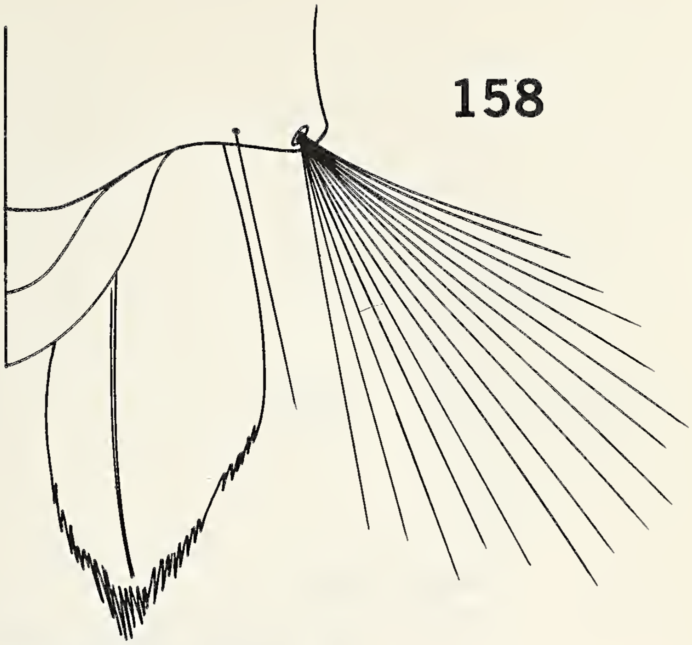

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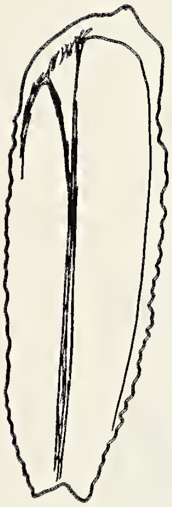

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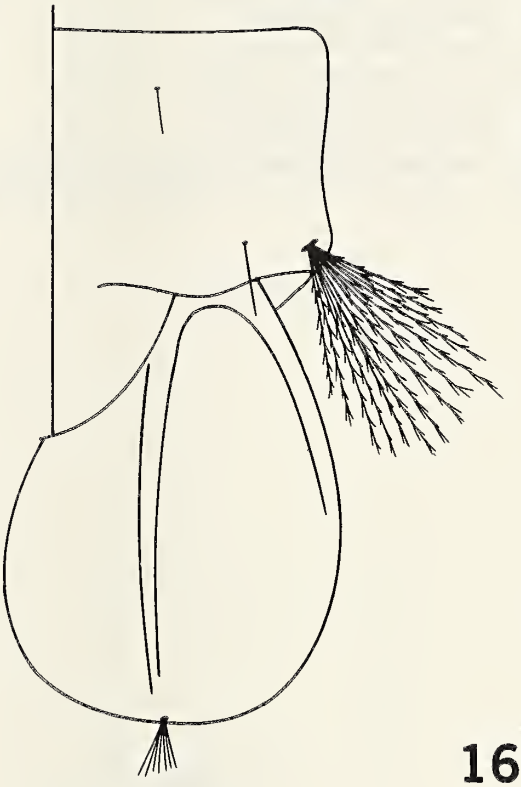

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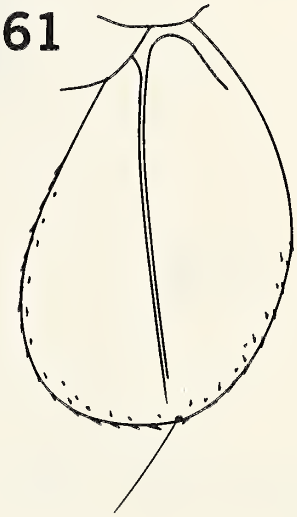

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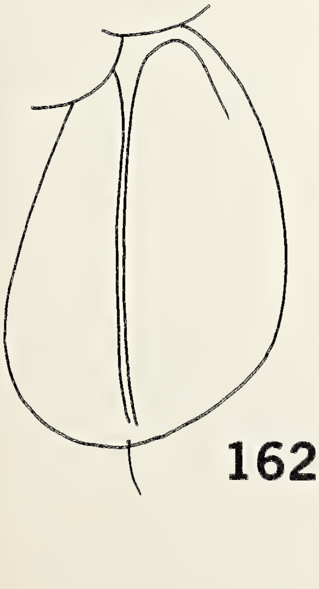

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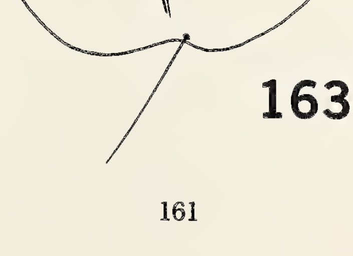

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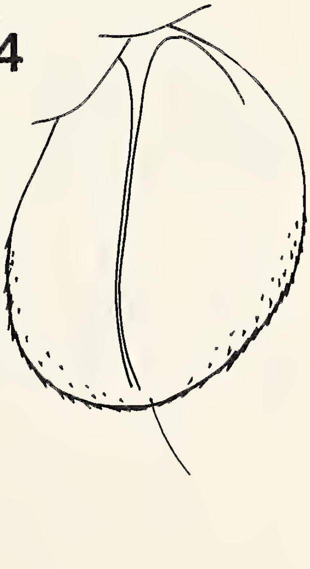

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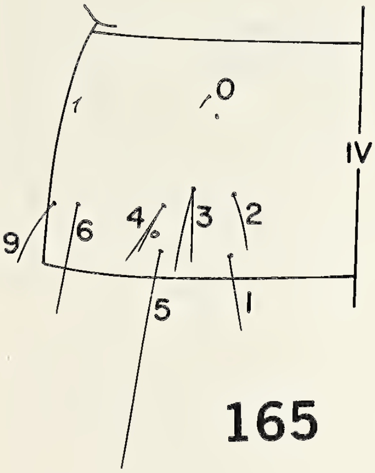
Plate XXVII

Figures 165–166. *Aedes aegypti,* pupa
- 165. Abdominal segment IV
- 166. Cephalothoracic setae
- 167–168. *A. atropalpus,* pupa
- 167. Abdominal segment II
- 168. Abdominal segment VII
- 169. *A. decticus,* abdominal segments I–III of pupa
- 170. *A. triseriatus,* abdominal segments II–IV of pupa



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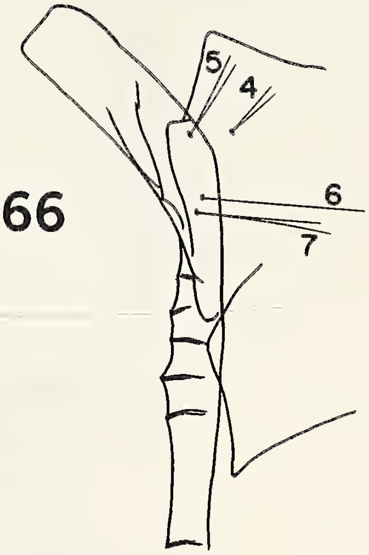

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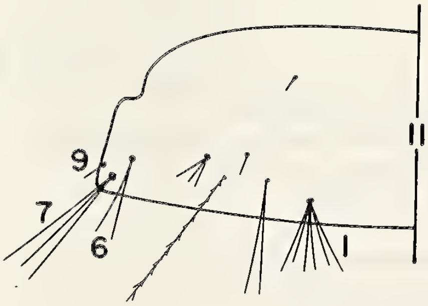

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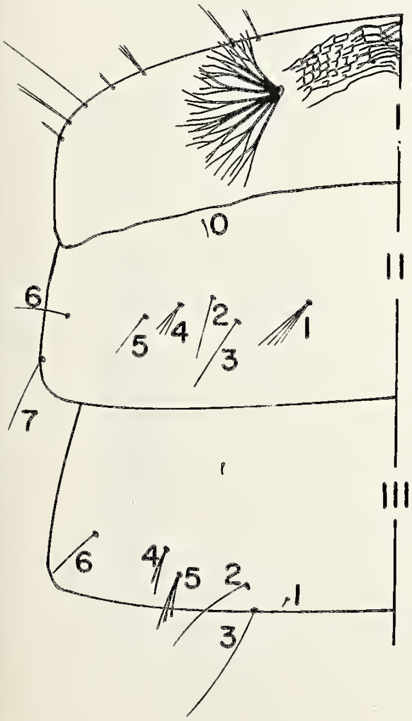

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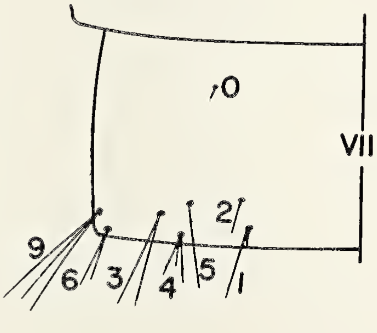

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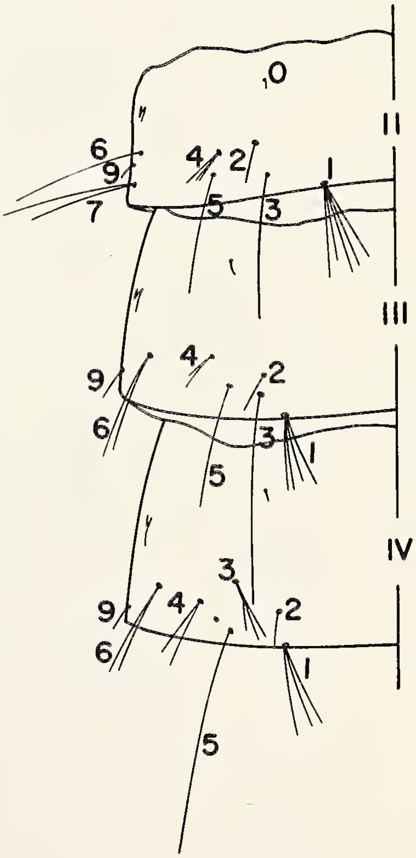

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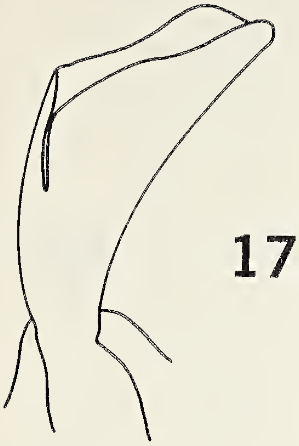
Plate XXVIII

Figures 171–179. Pupal respiratory trumpet
- 171. *Anopheles punctipennis*
- 172. *Toxorhynchites rutilus septentrionalis*
- 173. *Coquillettidia perturbans*
- 174. *Wyeomyia smithii*
- 175. *Culex restuans*
- 176. *Orthopodomyia signifera*
- 177. *Uranotaenia sapphirina*
- 178. *Psorophora confinnis*
- 179. *Culiseta melanura*



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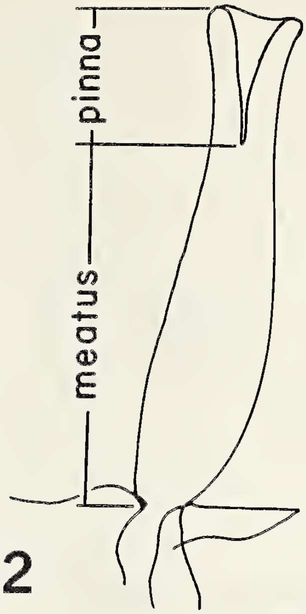

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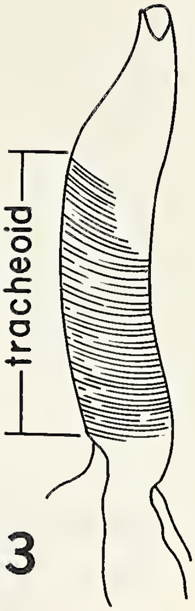

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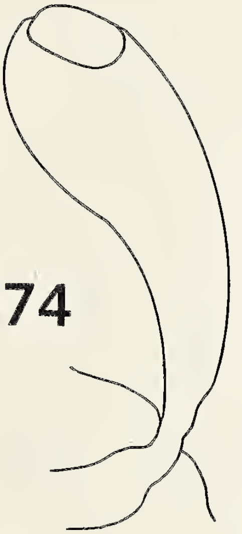

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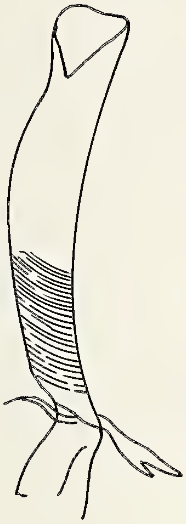

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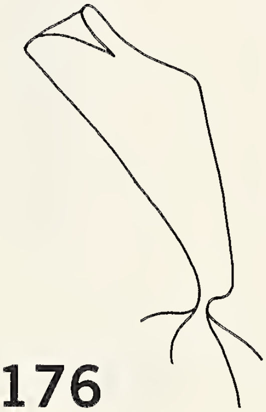

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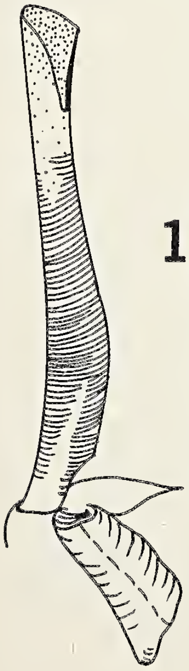

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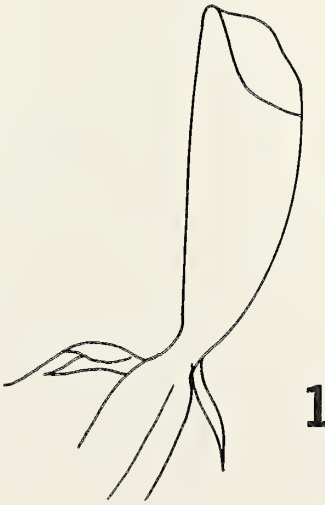

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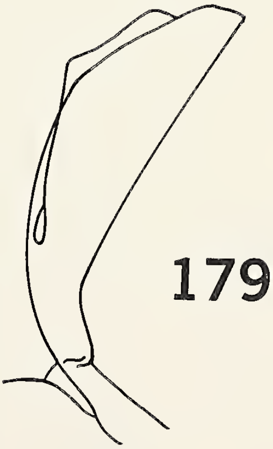

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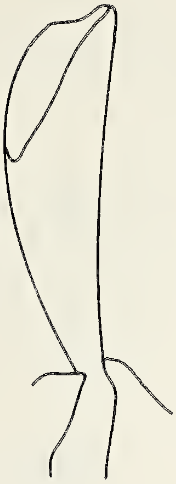
Plate XXIX

Figures 180–191. Pupal respiratory trumpets

- **180.** *Aedes atropalpus*
- **181.** *A. atlanticus*
- **182.** *A. taeniorhynchus*
- **183.** *A. trichurus*
- **184.** *A. excrucians*
- **185.** *A. cinereus*
- **186.** *A. punctor*
- **187.** *A. triseriatus*
- **188.** *A. canadensis*
- **189.** *A. sollicitans*
- **190.** *A. diantaeus*
- **191.** *A. decticus*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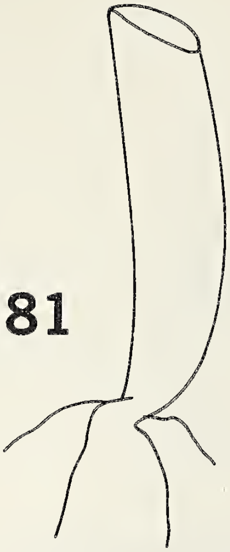
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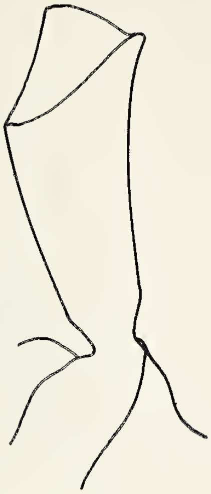
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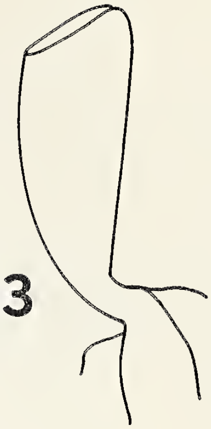
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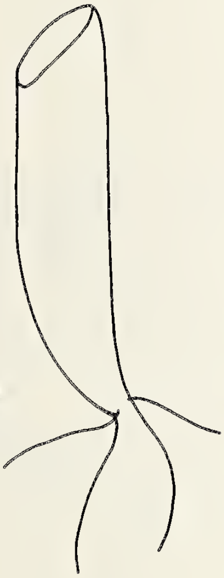
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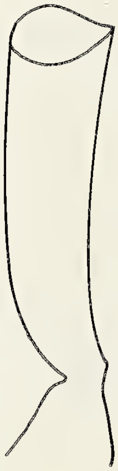
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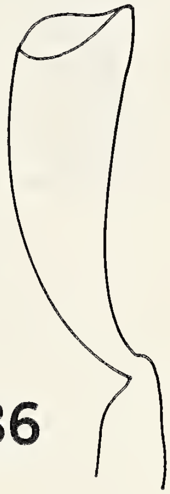
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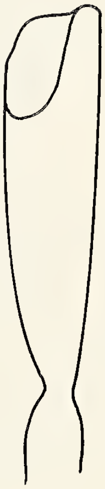
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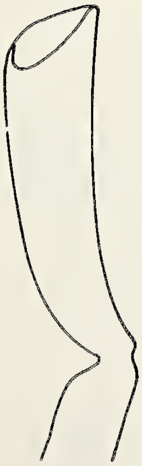
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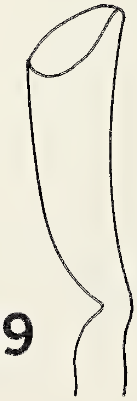
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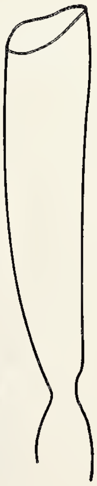
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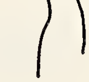
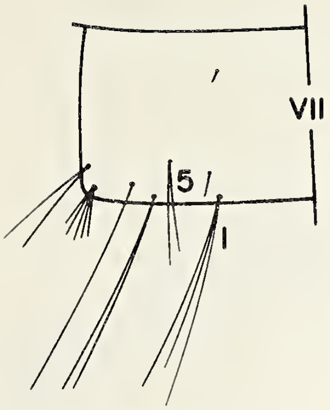

191

Plate XXX

Figures 192–200. Dorsal aspect of pupal abdominal segments

192. *Aedes excrucians*, segment VII
193. *A. vexans*, segments VI–VII
194. *A. cantator*, segments VI–VII
195. *A. communis*, segments I–II
196. *A. diantaeus*, segment VII
197. *A. stimulans*, segment VII
198. *A. sticticus*, metanotum
199. *A. sollicitans*, segment VII
200. *A. intrudens*, segment I



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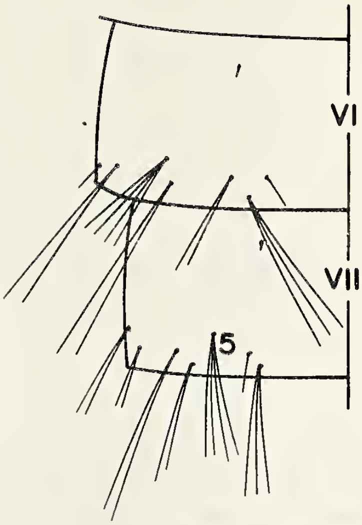

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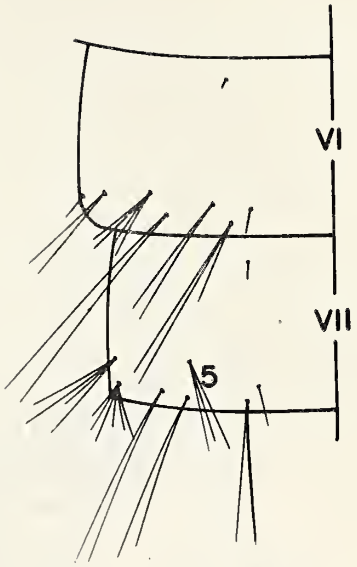

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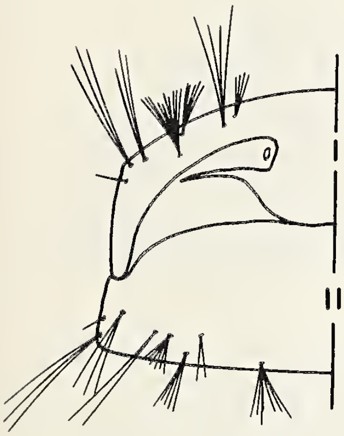

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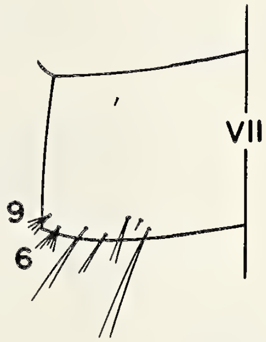

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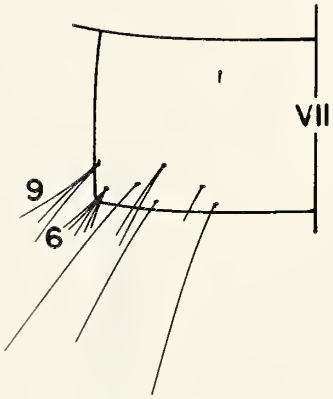

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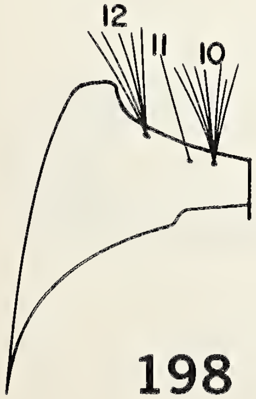

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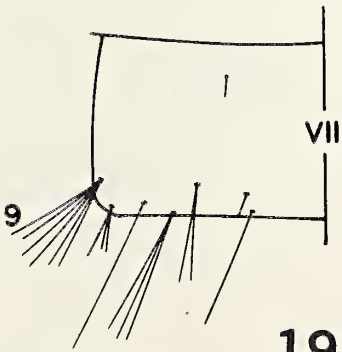

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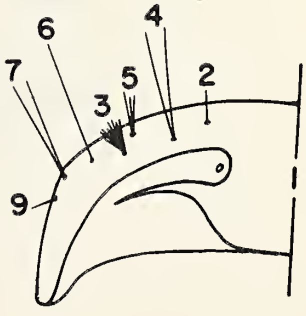
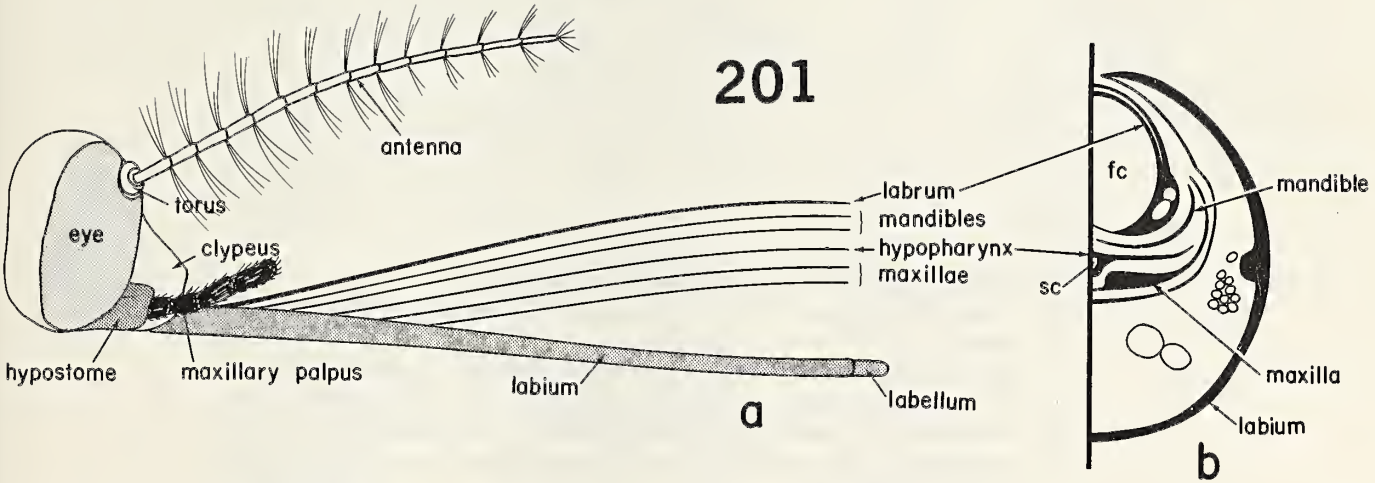
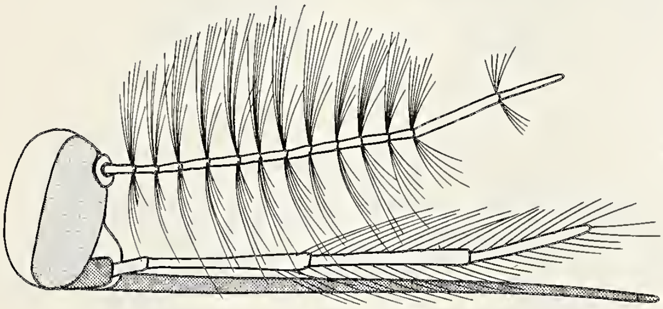


200

Plate XXXI

Figures 210–205. Antennae and mouthparts of adult mosquito
- 201. Culicine female, a. lateral aspect with stylets removed from labium, b. cross section
- 202. Culicine male
- 203. Anopheline male
- 204. Anopheline female
- 205. Enlarged view of culicine female antenna


201
antenna
torus
eye
clypeus
hypostome
maxillary palpus
labium
labellum
labrum
mandibles
hypopharynx
maxillae
a
fc
sc
mandible
maxilla
labium
b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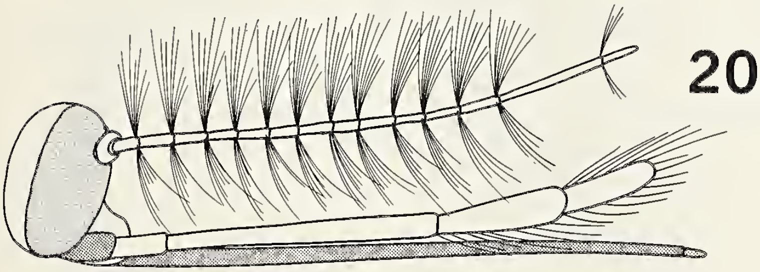
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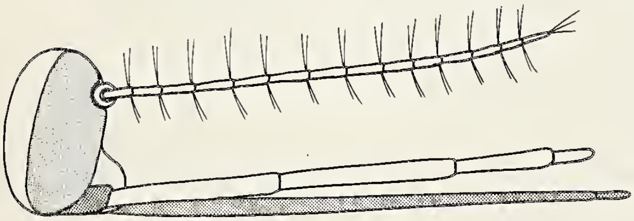
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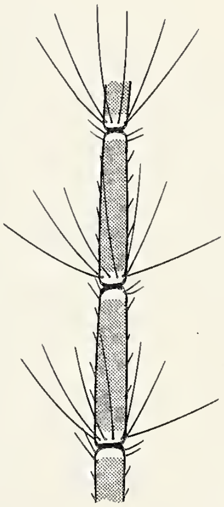
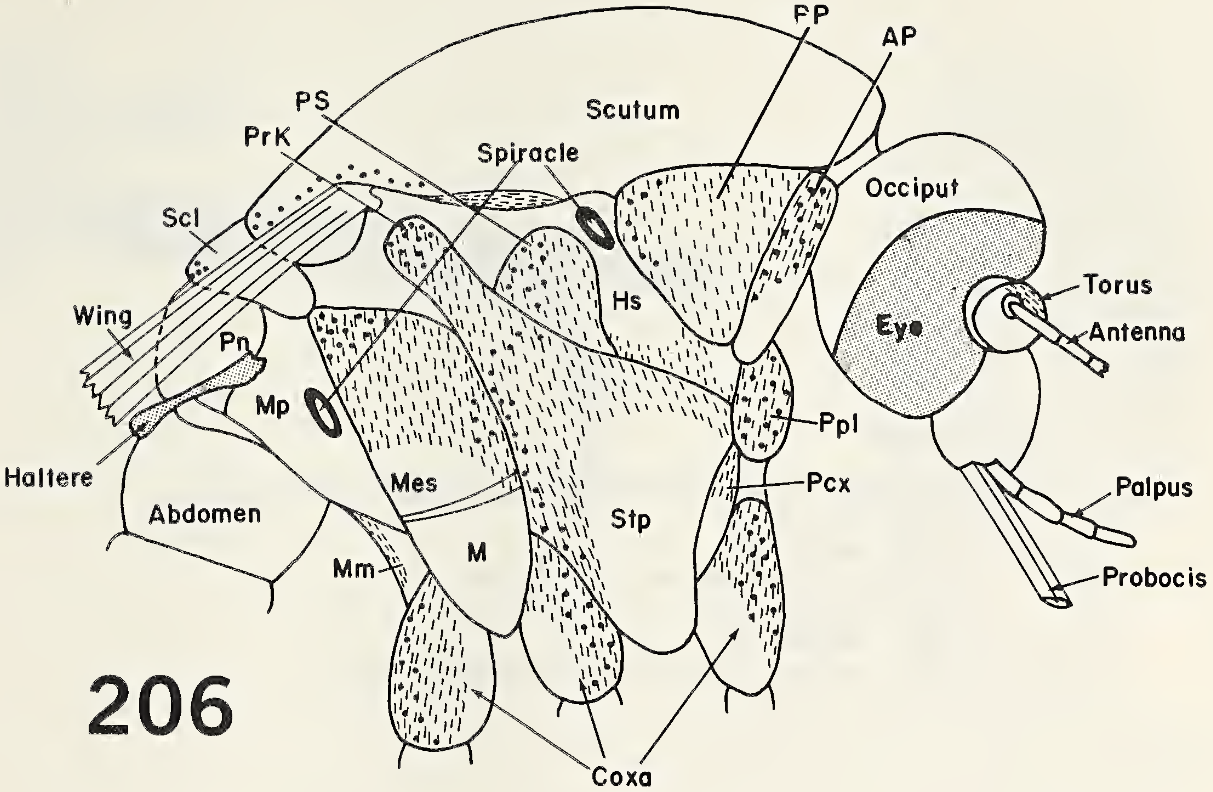

205

Plate XXXII

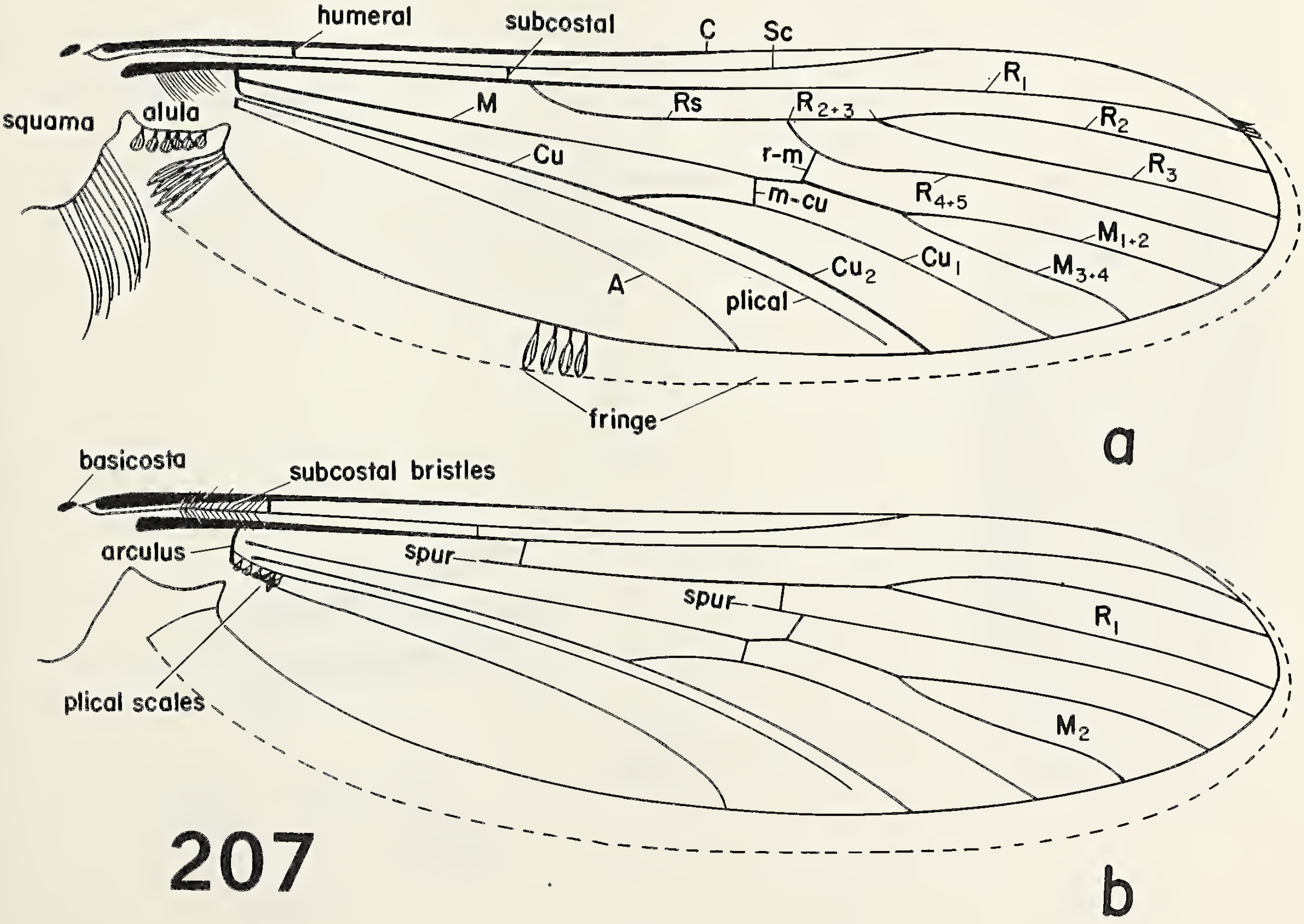
Figures 206. Pleural scale area of adult female mosquito

207. Generalized mosquito wing venation, a. dorsal aspect, b. ventral aspect

AP—anterior pronotum, PP—postpronotum, Ppl—propleuron, Pcx—postcoxal area, Stp—sternopleuron, Hs—hypostigial area, Prk—prealar knob, PS—postscutum, Scl—scutellum, Pn—postnotum, Mp—metapleuron, Mes—mesepimeron, M—meron, mm—metameron


FP
AP
PS
Scutum
PrK
Spiracle
Occiput
Scl
Hs
Torus
Antenna
Wing
Eye
Pn
Mp
Ppl
Pcx
Haltere
Mes
Palpus
Abdomen
Stp
M
Mm
Probocis
Coxa

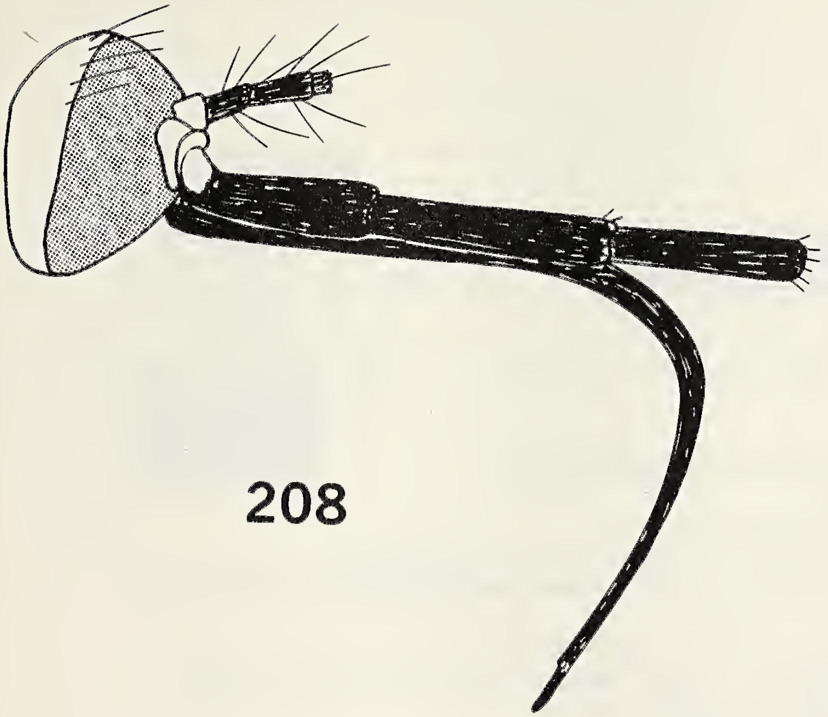
206


humeral
subcostal
C
Sc
R1
squama
alula
M
Rs
R2+3
R2
Cu
r-m
R3
m-cu
R4+5
M1+2
Cu1
M3+4
Cu2
A
plical
fringe
a
basicosta
subcostal bristles
arculus
spur
spur
R1
plical scales
M2
b

207

Plate XXXIII

Figures 208–209. *Toxorhynchites rutilus septentrionalis,* adult female
  208. Head
  209. Apex of wing
  210–211. *Culex restuans,* adult female
  210. Wing squama
  211. Mesonotum
  212. *Anopheles earlei,* mesonotum of adult female



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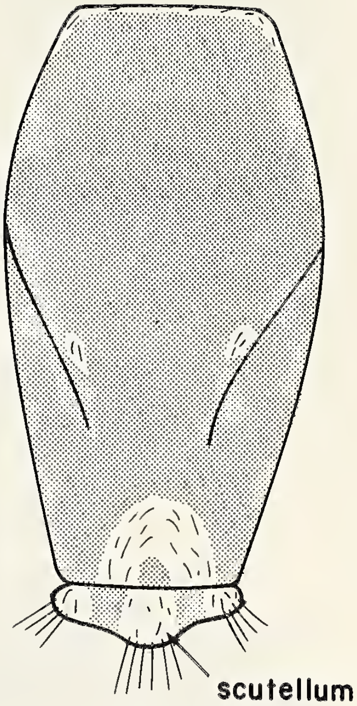

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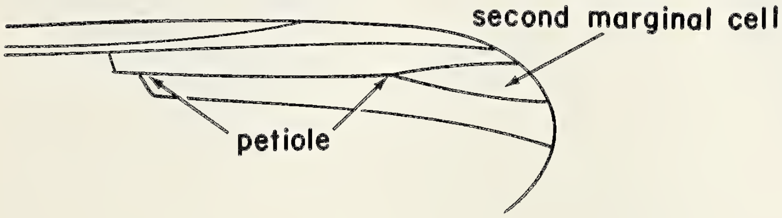

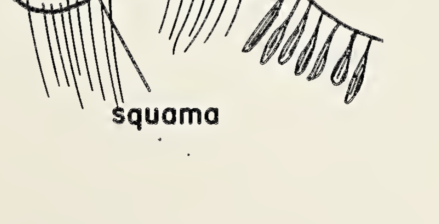

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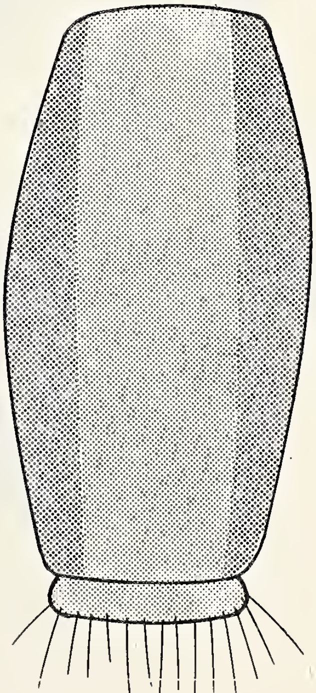
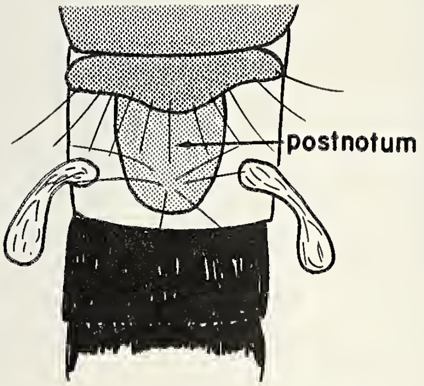


212

Plate XXXIV

Figures 213–214. *Wyeomyia smithii*, adult female
- 213. Postnotum
- 214. Lateral aspect of abdomen
- 215. *Culiseta impatiens*, spiracular setae of adult female
- 216. *Psorophora ferox*, spiracular and postspiracular setae of adult female
- 217. *Aedes vexans*, postspiracular setae of adult female
- 218. *Culiseta impatiens*, base of costa and subcosta of adult female, a. ventral aspect, b. lateral aspect



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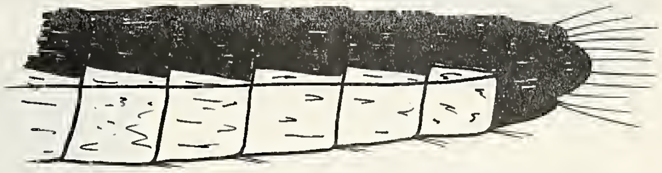

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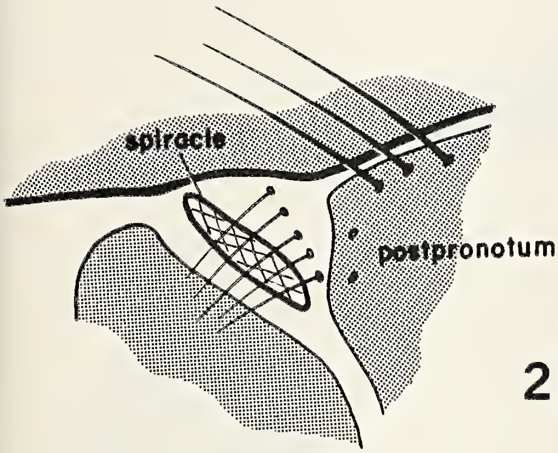

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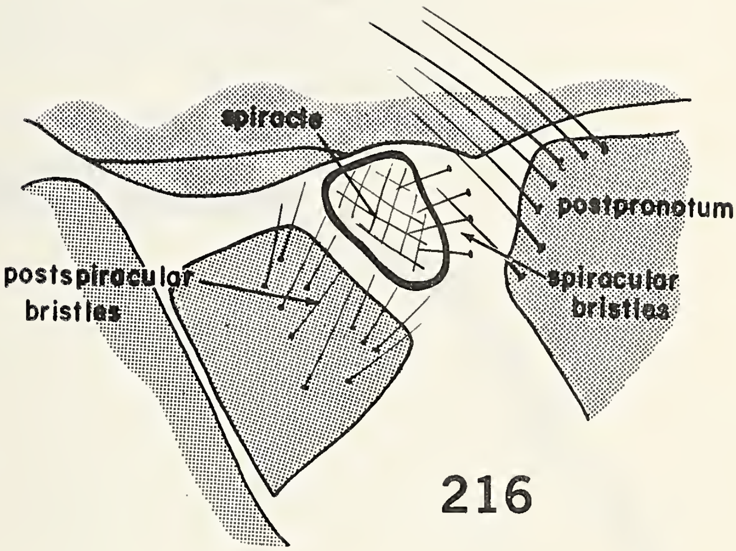

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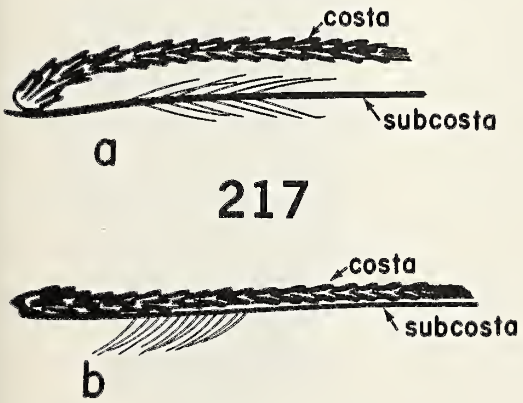

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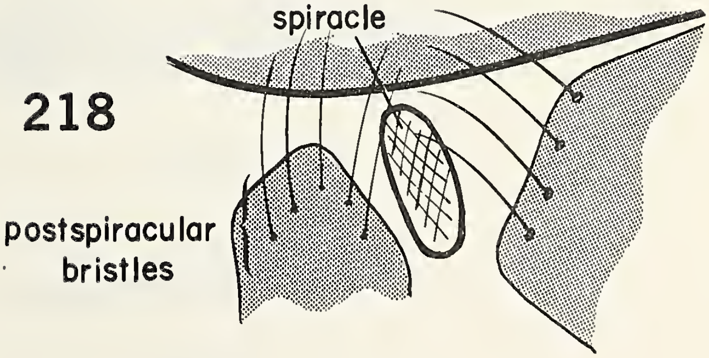
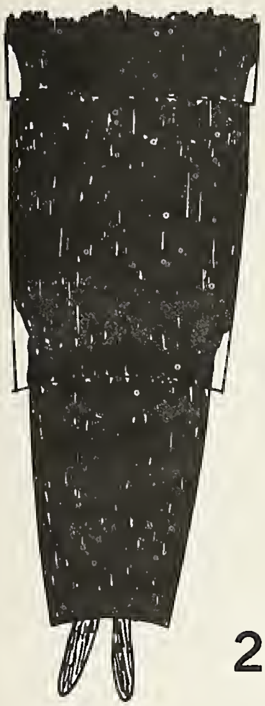


218

Plate XXXV

Figures 219–221. Apex of female abdomen
- 219. *Psorophora ferox*
- 220. *Culex territans*
- 221. *Culiseta impatiens*
- 222. *Orthopodomyia* sp., mesonotum
- 223. *Coquillettidia perturbans,* hind leg
- 224–225. Costal scales
- 224. *C. perturbans*
- 225. *C. territans*, a. individual scales



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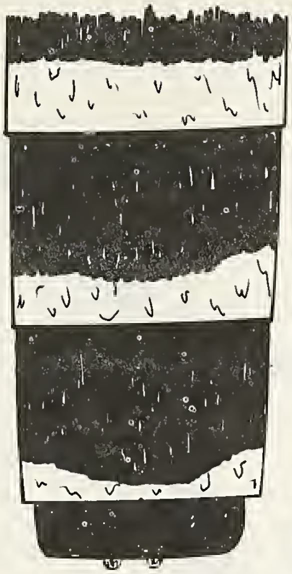

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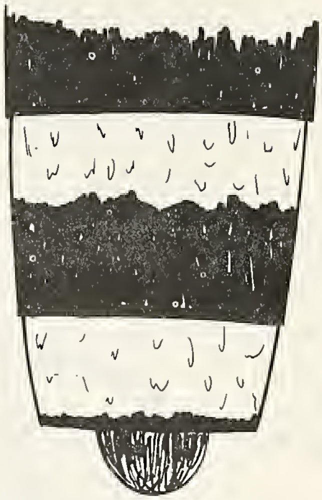

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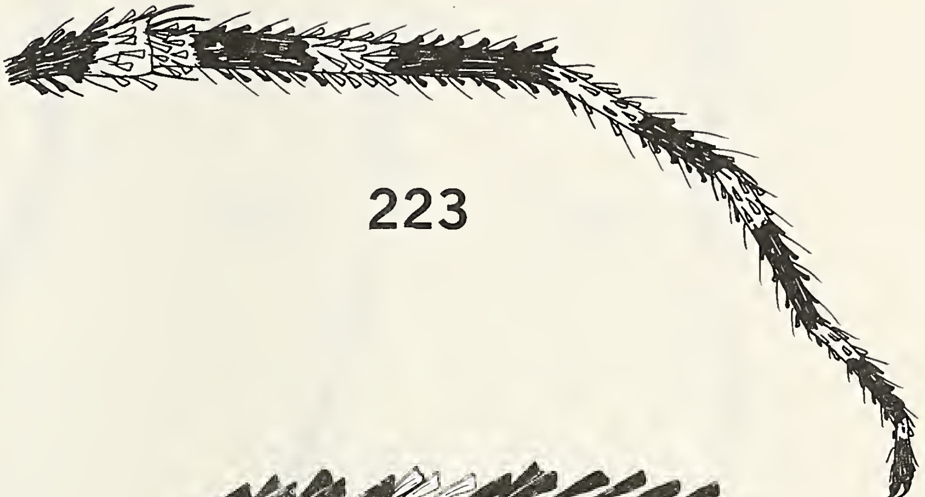

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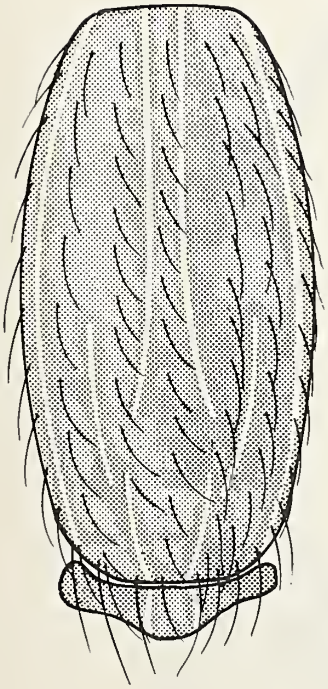

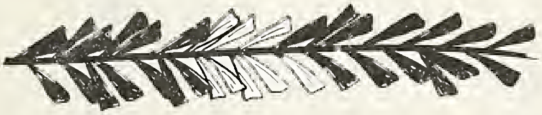

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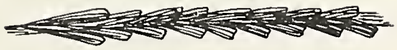

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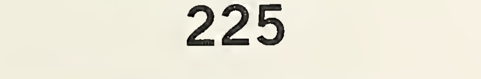
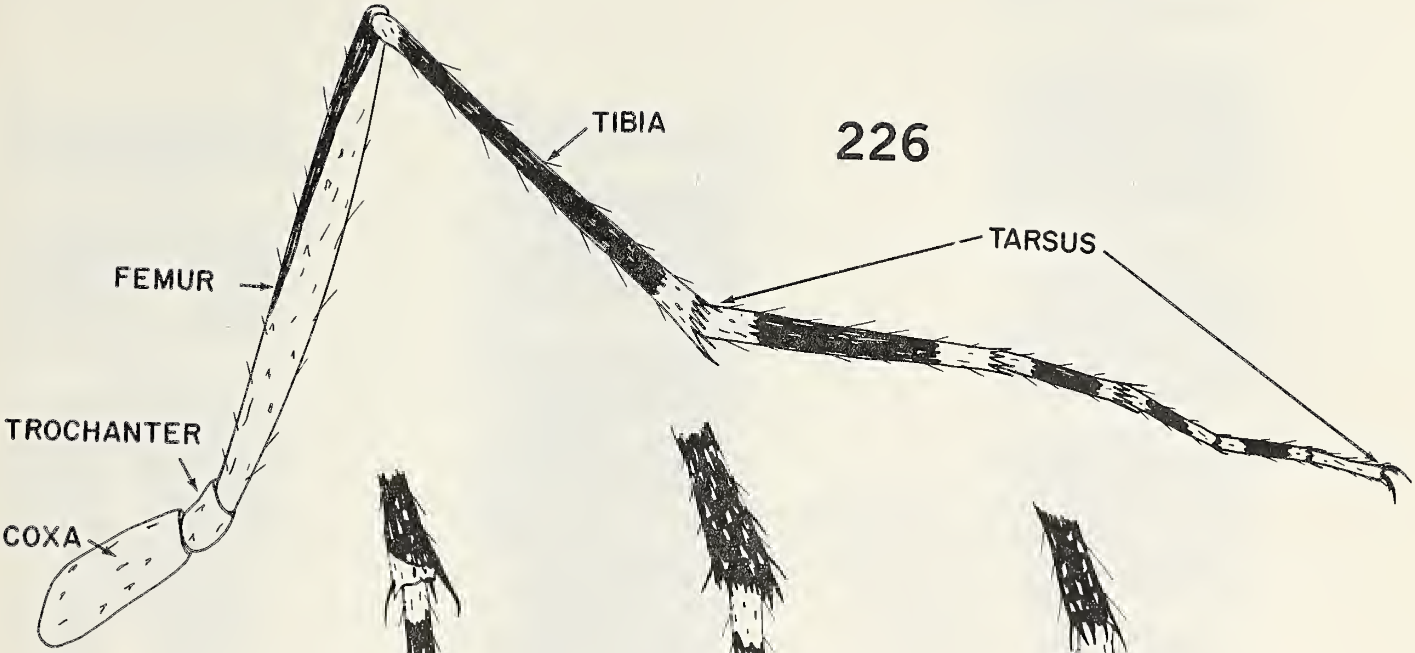


a

Plate XXXVI

Figures 226. *Aedes canadensis*, hind leg
227–229. Hind tarsus
227. *A. vexans*
228. *A. sollicitans*
229. *A. excrucians*
230. *A. sollicitans*, proboscis



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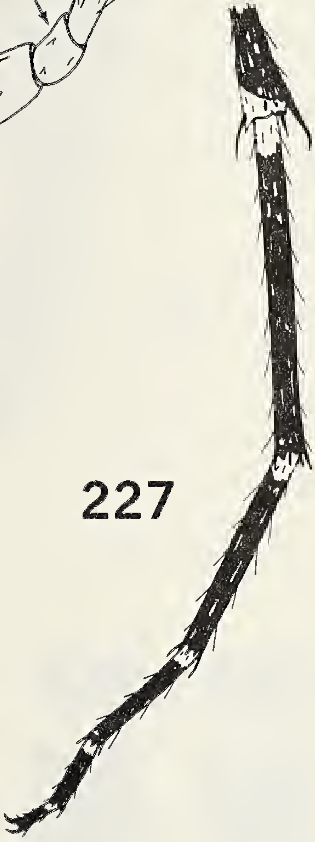

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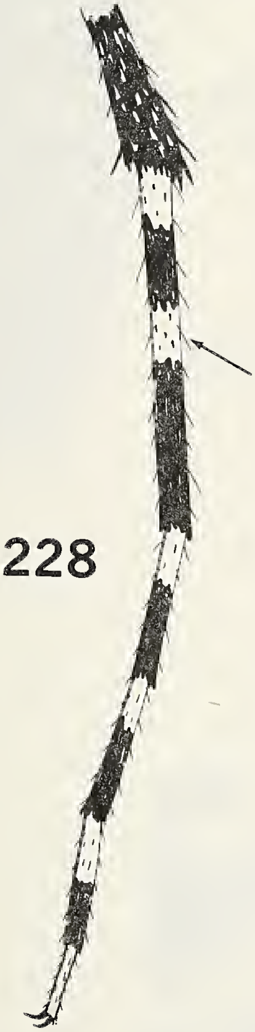

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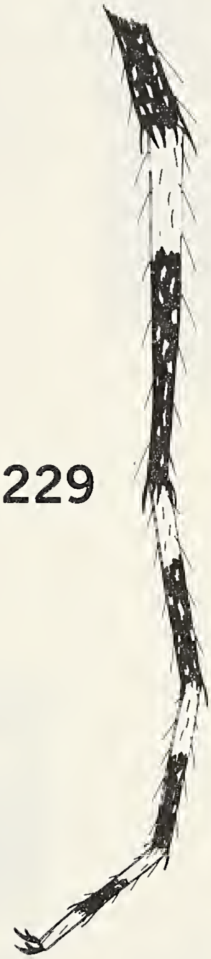

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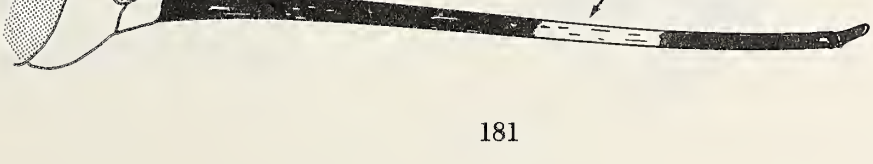

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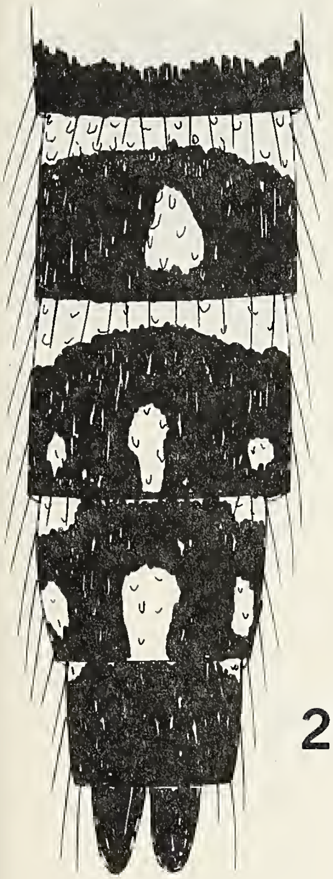
Plate XXXVII

Figures 231–235. Adult females showing abdominal tergites

231. *Aedes mitchellae*
232. *A. taeniorhynchus*
233. *A. fitchii*
234. *A. sollicitans*
235. *A. vexans*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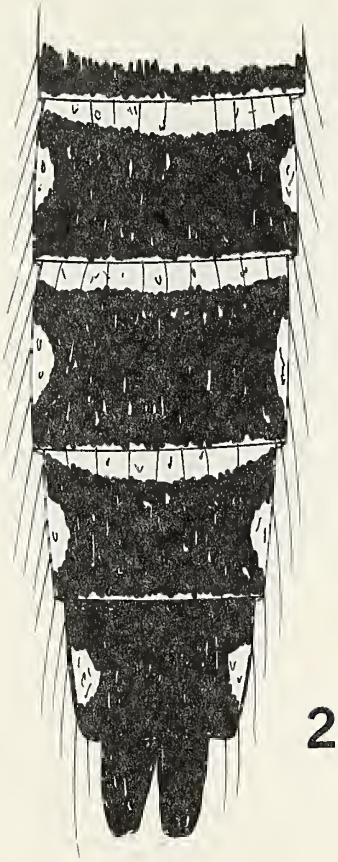
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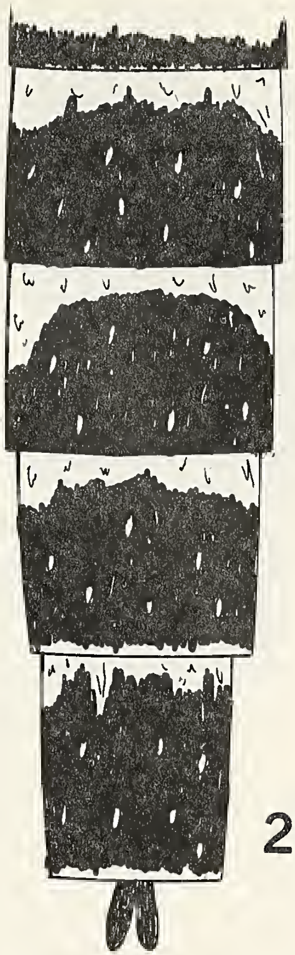
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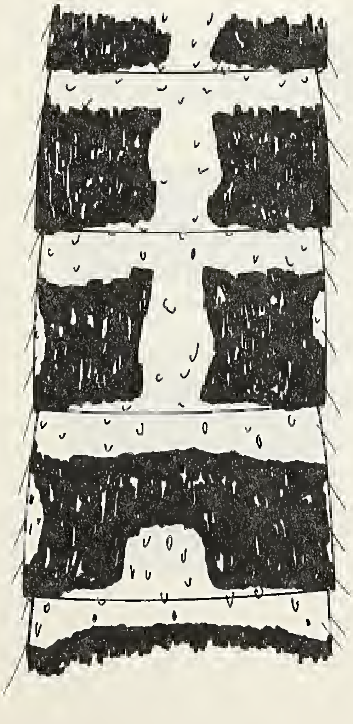
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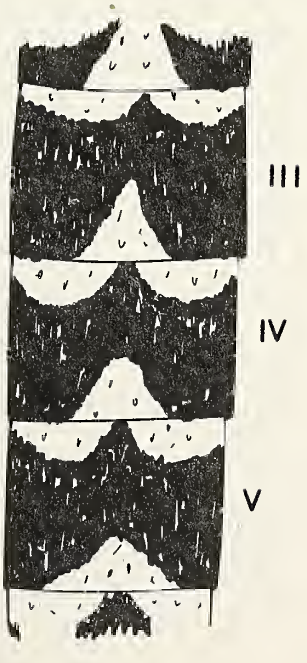

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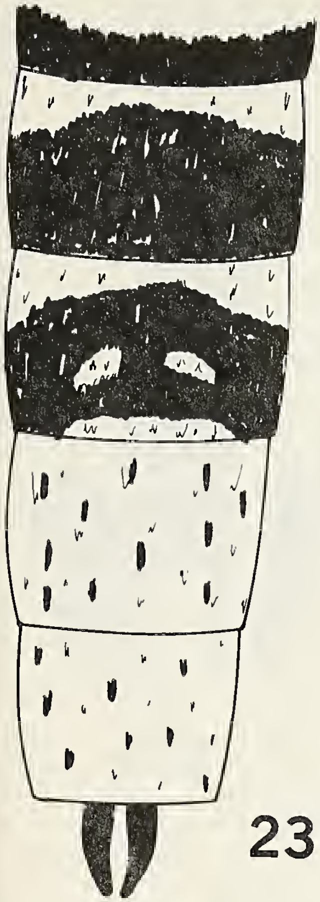
Plate XXXVIII

Figures 236–240. Adult females showing abdominal tergites
236. *Aedes cantator*
237. *A. implicatus*
238. *A. aurifer*
239. *A. barri*
240. *A. flavescens*



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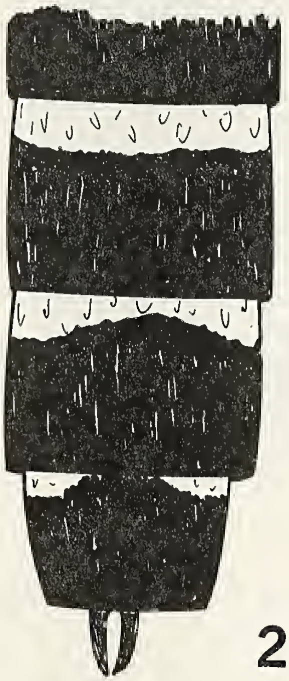

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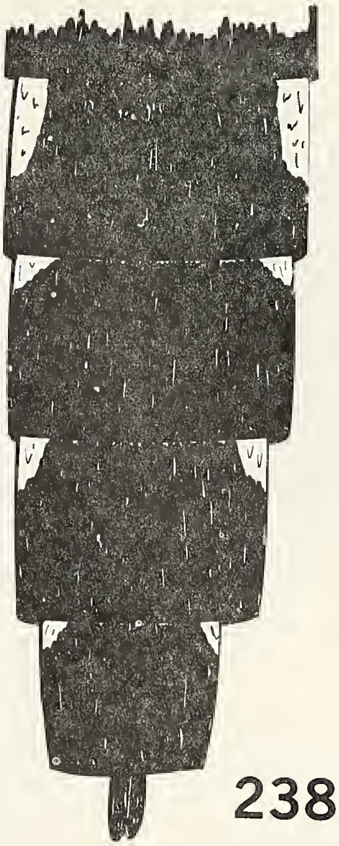

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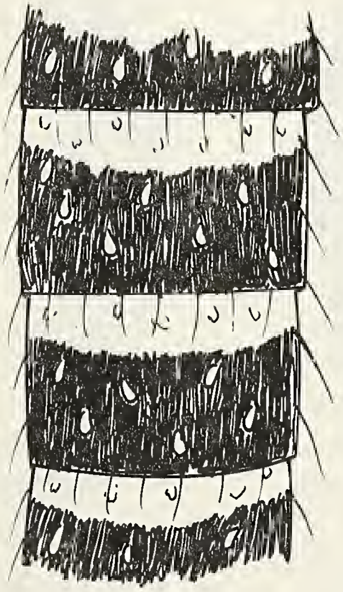

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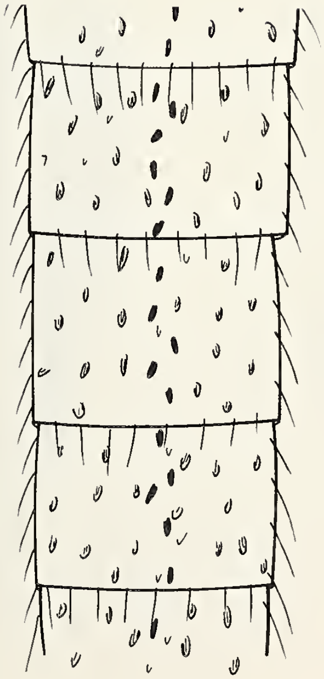

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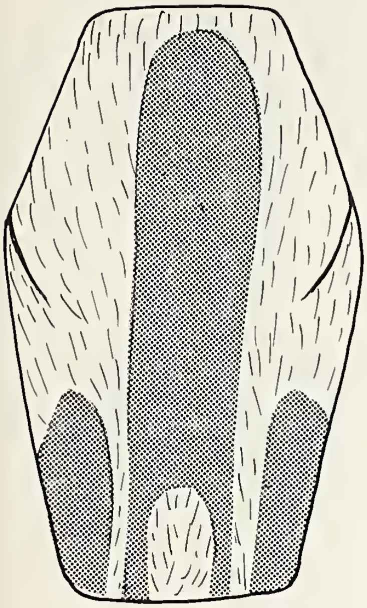
Plate XXXIX

Figures 241–246. Adult females showing mesonotal scale patterns

241. ***Aedes atropalpus***
242. ***A. canadensis***
243. ***A. punctor***
244. ***A. atlanticus***
245. ***A. trivittatus***
246. ***A. sticticus***



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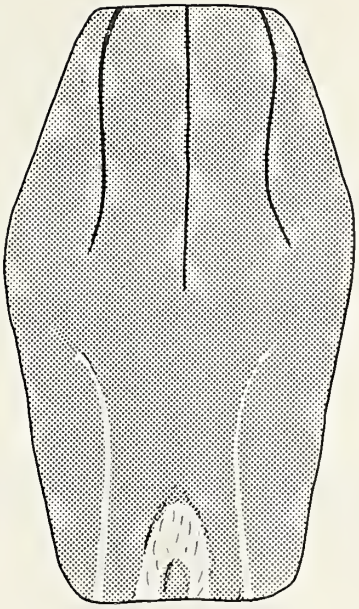

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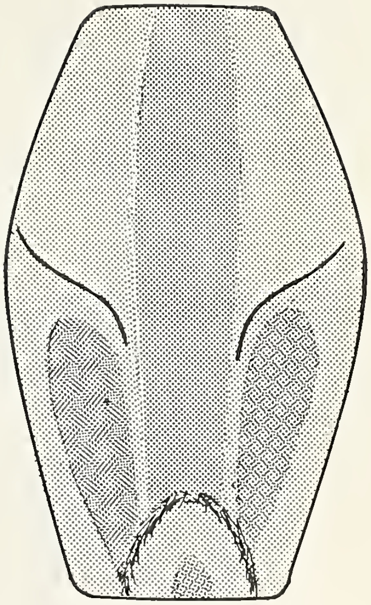

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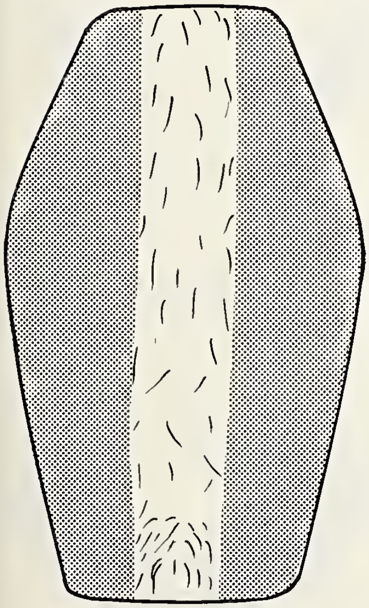

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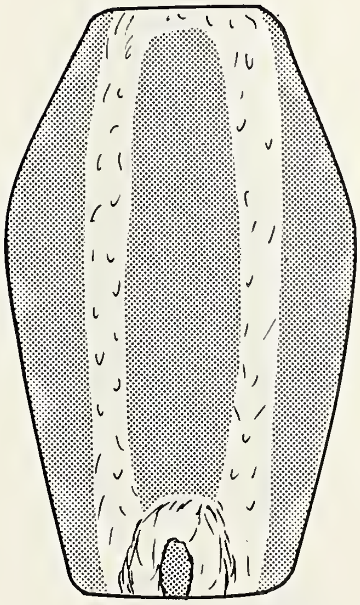

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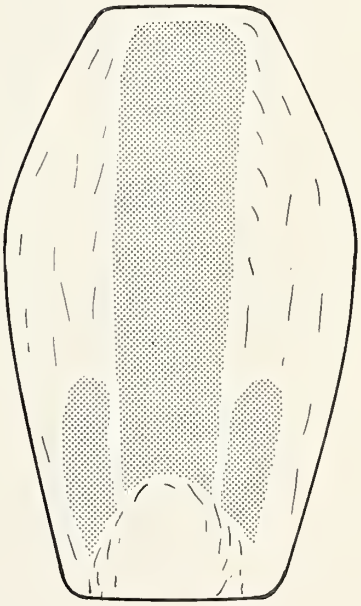
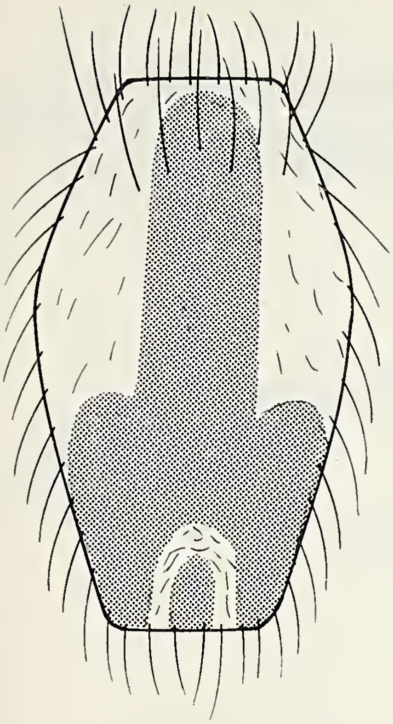


246

Plate XL

Figures 247–249. Adult females showing mesonotal scale patterns
247. *Aedes hendersoni*
248. A. *diantaeus*
249. A. *triseriatus*
250. Forecoxae, a. A. *cinereus*, A. *aurifer*
251. A. *aurifer*, mesonotal scale pattern
252. Individual scales from lateral area of mesonotum, a. A. *thibaulti*, b. A. *triseriatus*
253. A. *implicatus*, showing "knee spot" on hind leg



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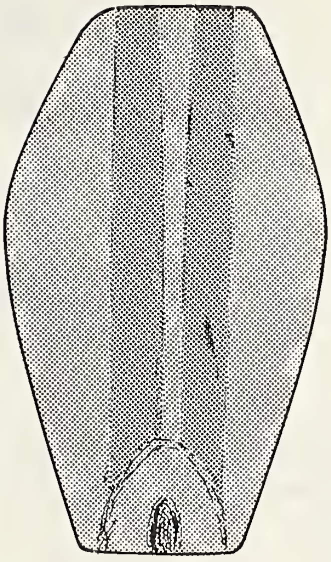

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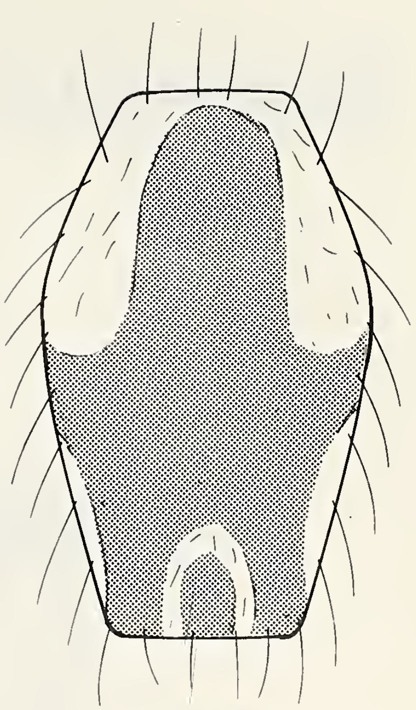

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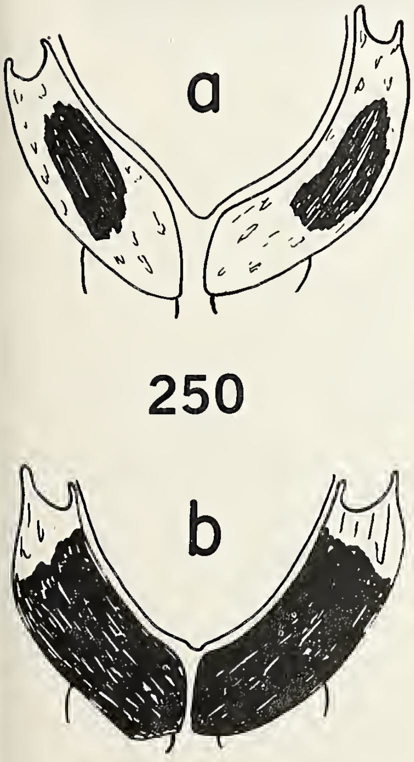

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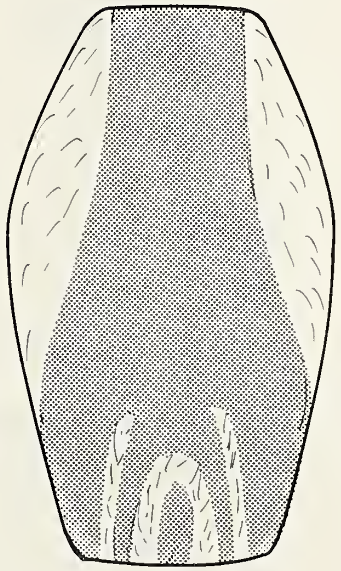

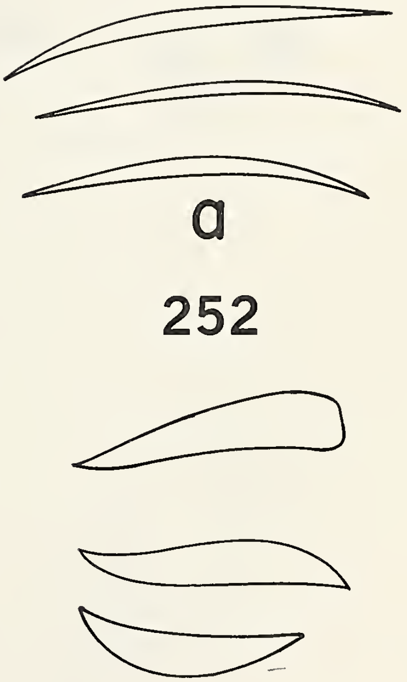

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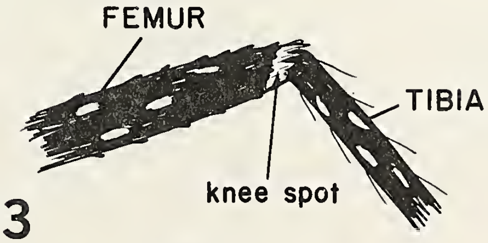
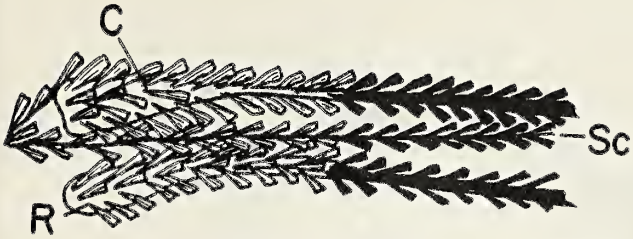


253

Plate XLI

Figures 254–259. Wing scales. C—costa, Sc—subcosta, R—radius

254. *Aedes atropalpus*
255. *A. dorsalis*
256. *A. hexodontus*
257. *A. sollicitans*
258. *A. spencerii*
259. *A. grossbecki*, a. individual scale
260. Tarsal claw of hind leg, a. *A. excrucians*, b. *A. fitchii*, c. *A. riparius*



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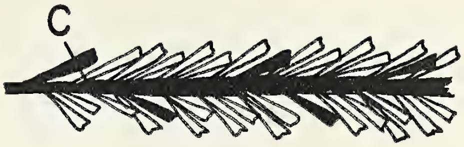

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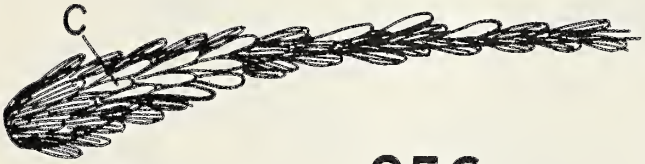

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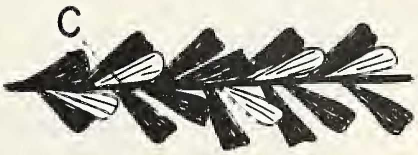

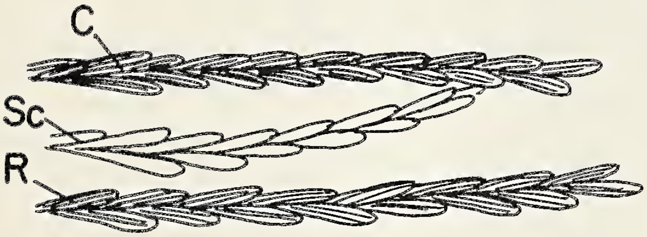

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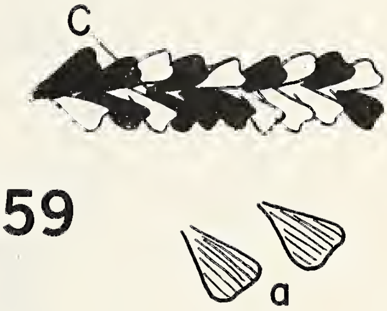

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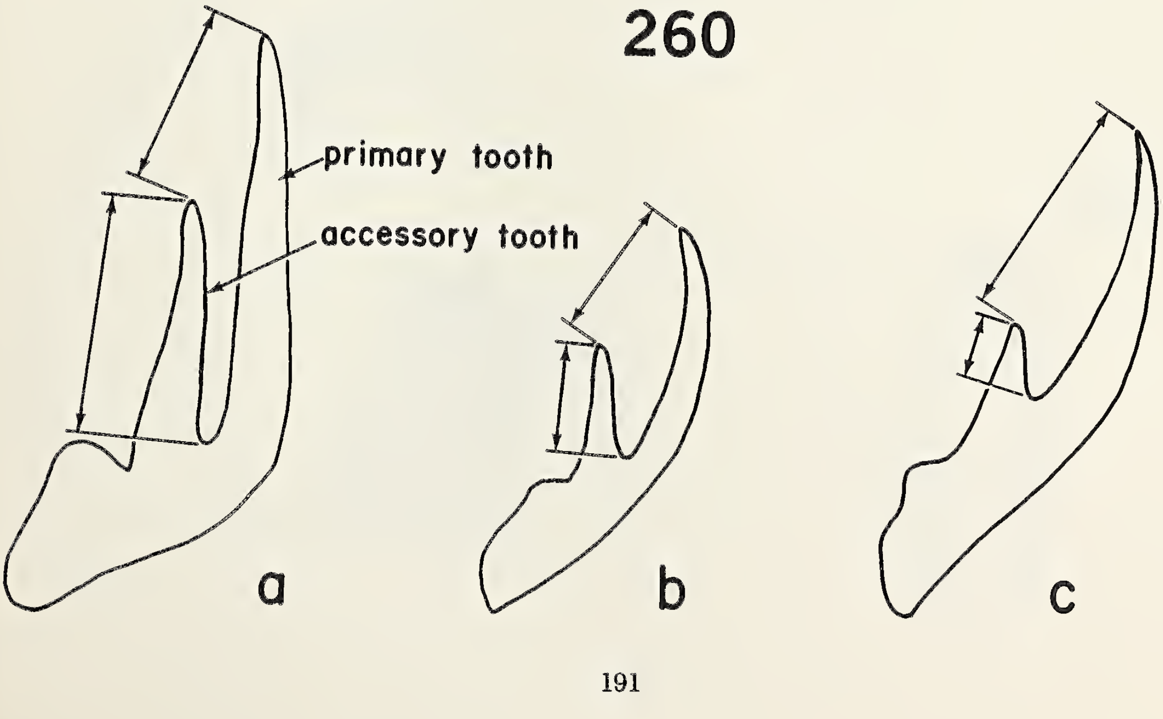
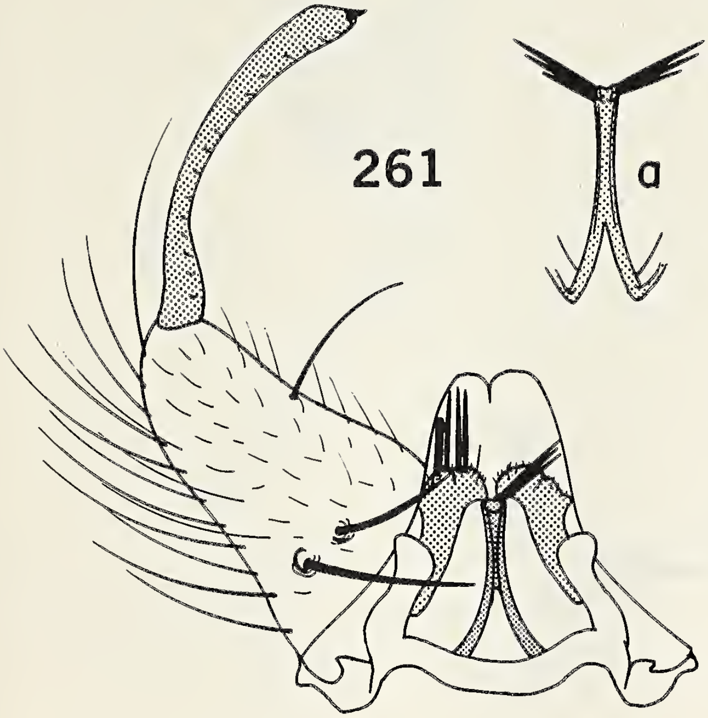


Plate XLII

Figures 261–264. Male terminalia
- 261. *Anopheles quadrimaculatus*, a. phallosome
- 262. *Psorophora ciliata*
- 263. *Culex pipiens*
- 264. *Culex territans*, showing tenth sternite

261



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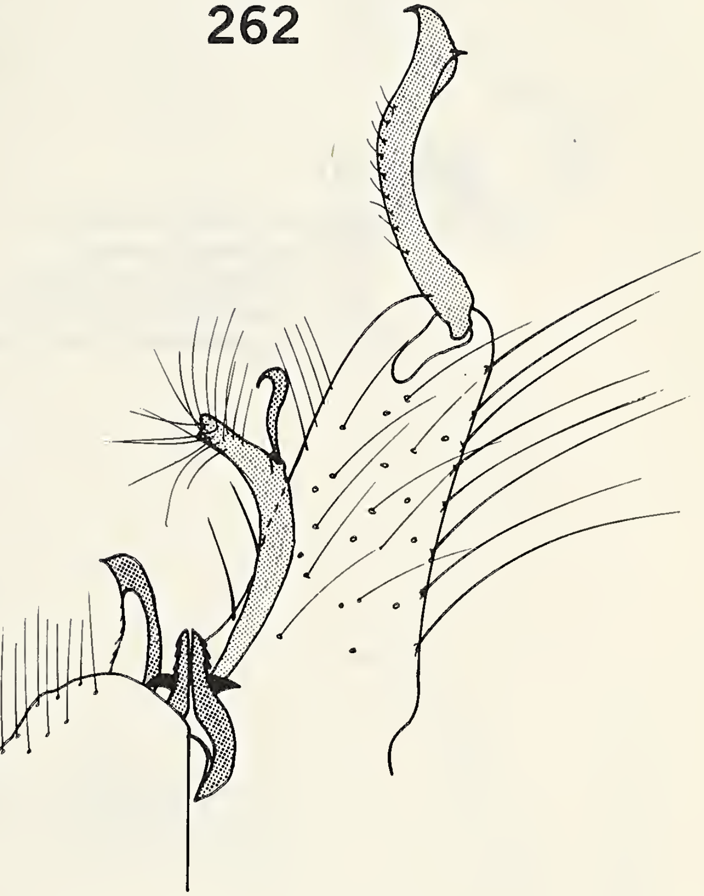

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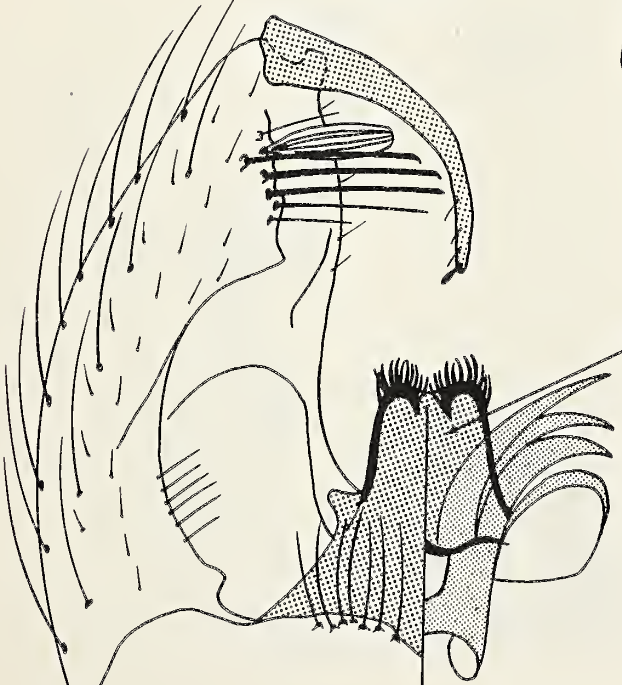


tenth sternite

264

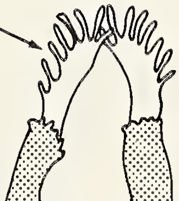
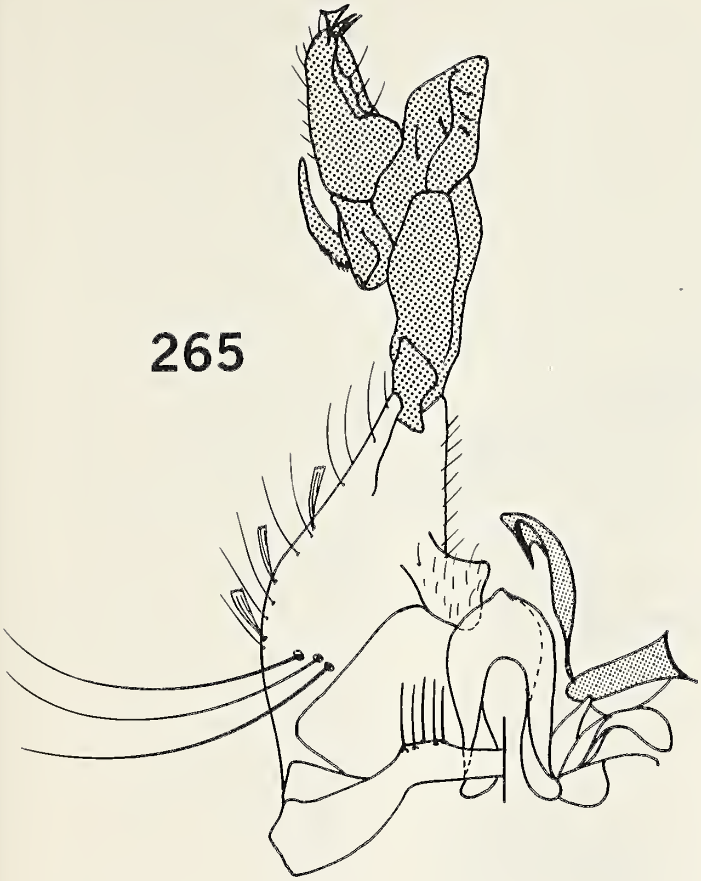


Plate XLIII

Figures 265–268. Male terminalia
265. *Wyeomyia smithii*
266. *Uranotaenia sapphirina*
267. *Coquillettidia perturbans*
268. *Orthopodomyia alba*, a. apical claw

265



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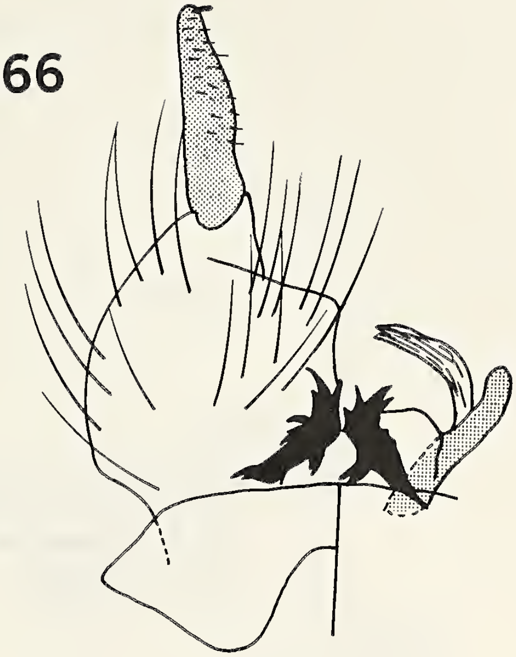

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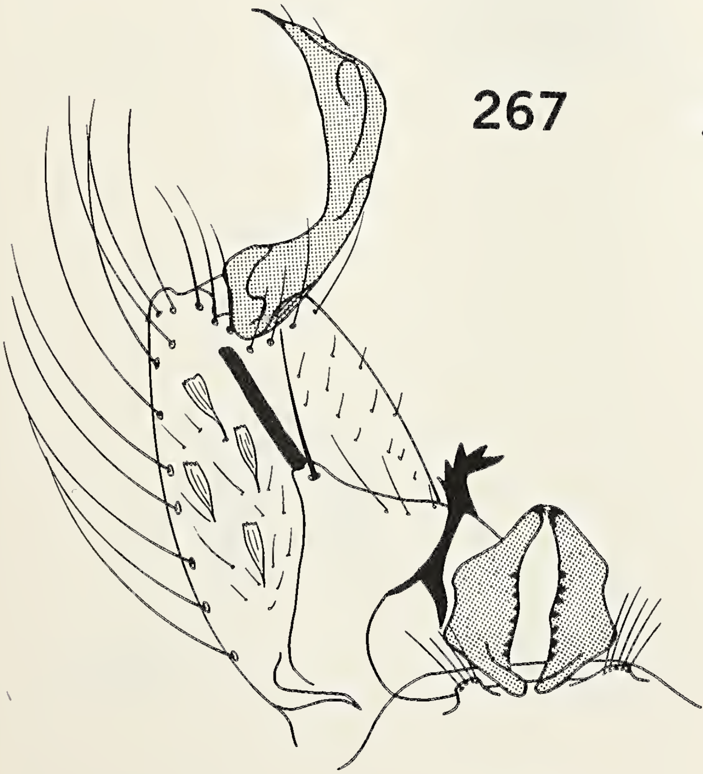

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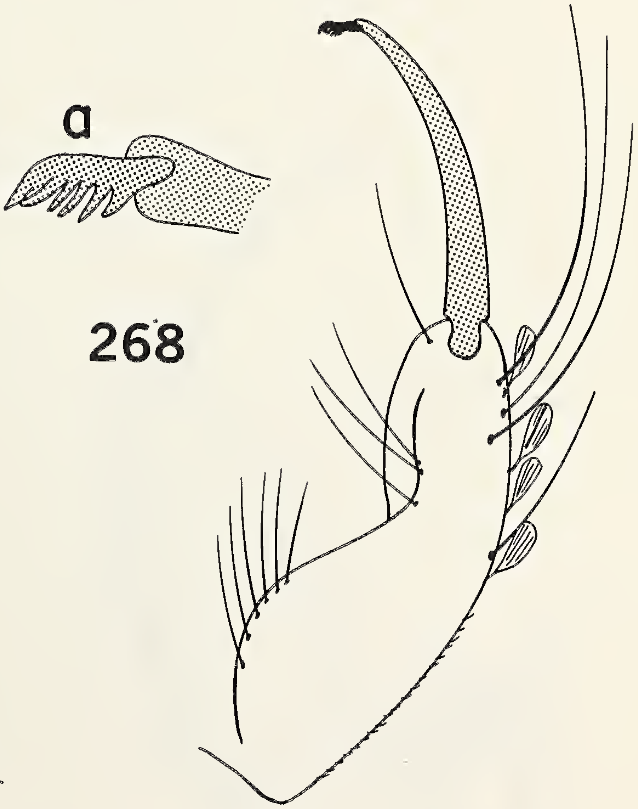
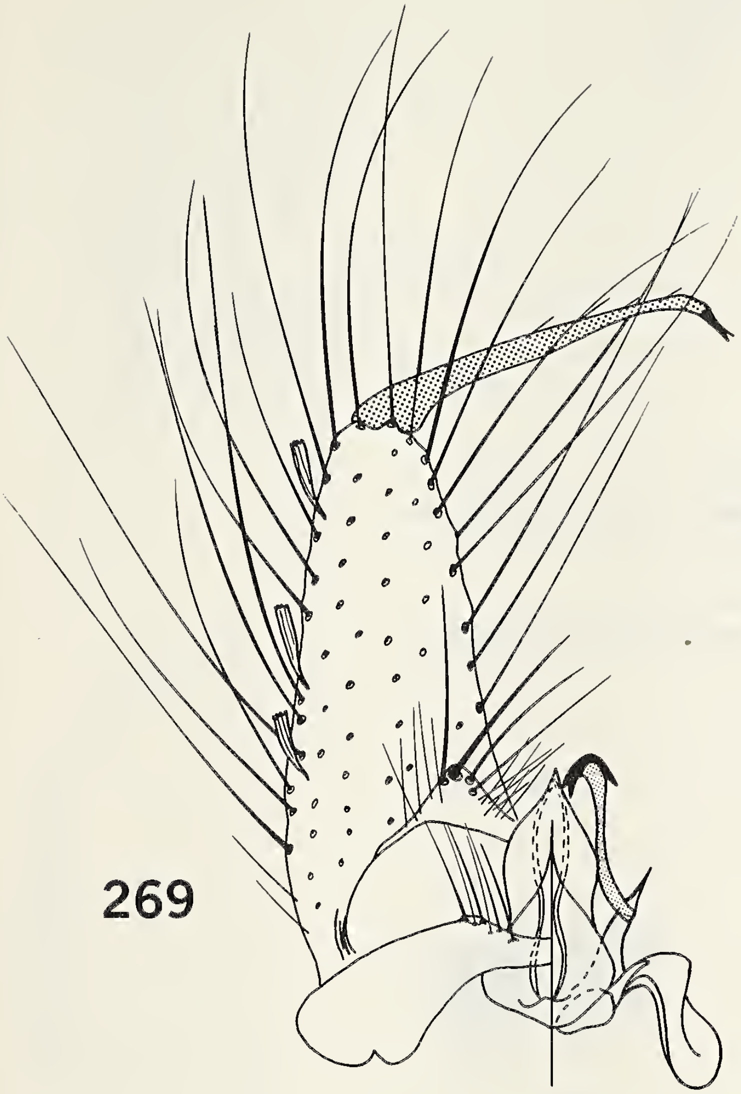


Plate XLIV

Figures 269–272. Male terminalia
- 269. *Culiseta morsitans dyari*
- 270. *Toxorhynchites rutilus septentrionalis*
- 271. *Aedes aegypti*
- 272. *A. atropalpus*



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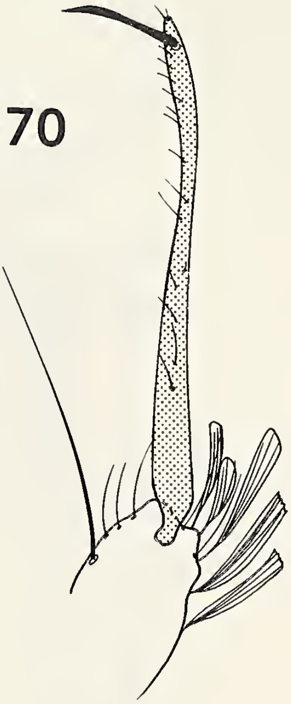

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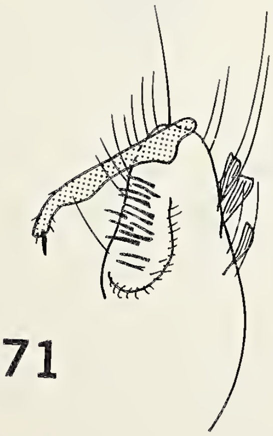

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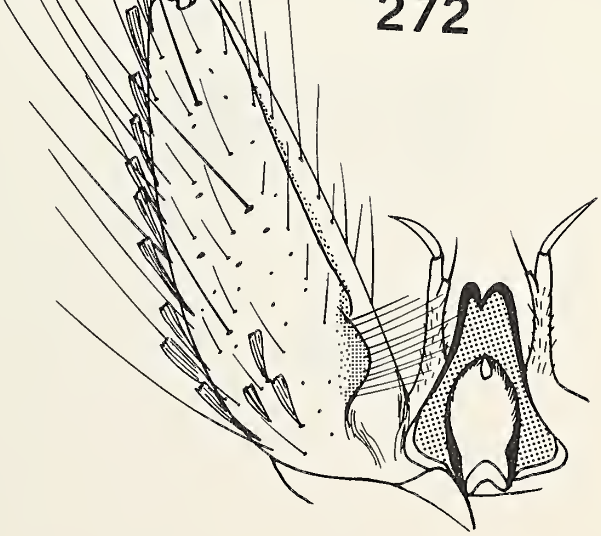

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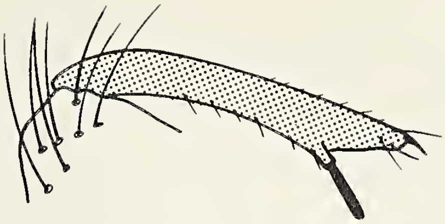
Plate XLV

Figures 273–277. Male terminalia
- 273. *Aedes cinereus*, apex of basistyle and dististyle
- 274. *A. vexans*, dististyle
- 275. *A. triseriatus*
- 276. *A. hendersoni*, median tuft
- 277. *A. diantaeus*, a. median tuft, ventral aspect



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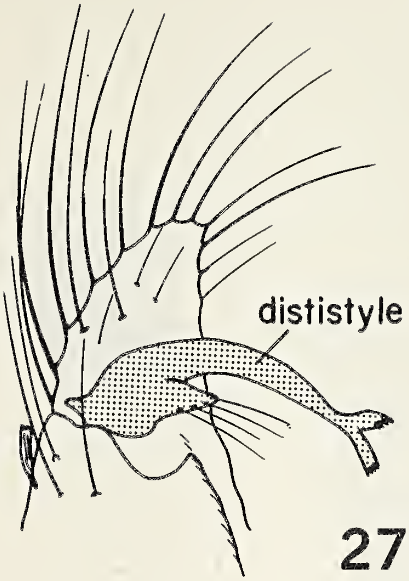

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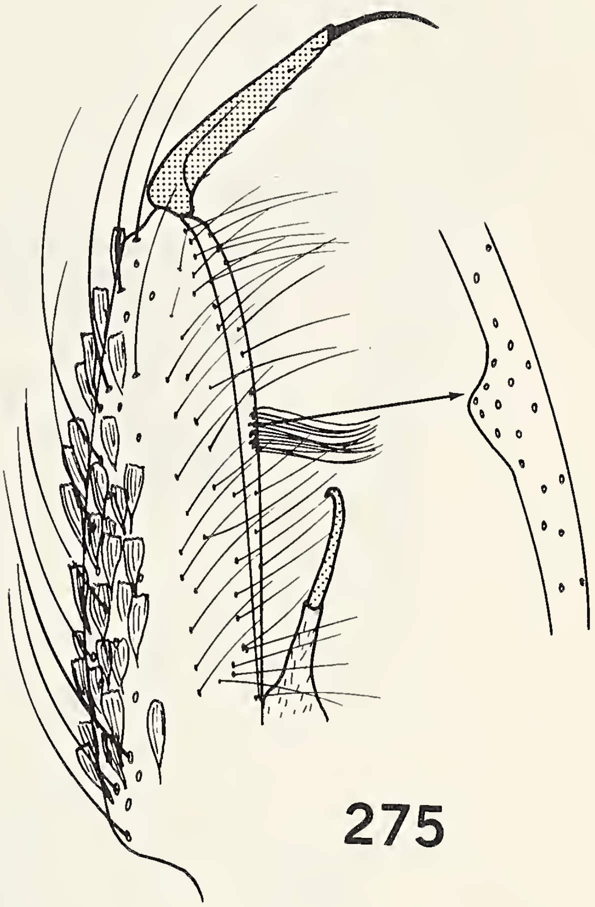

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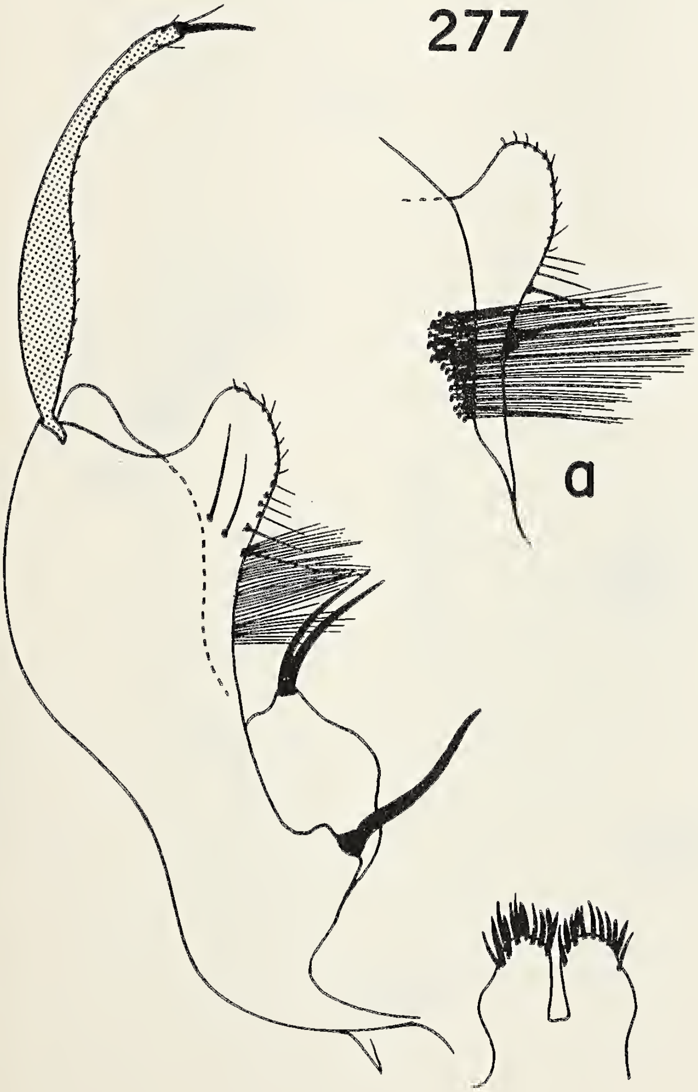

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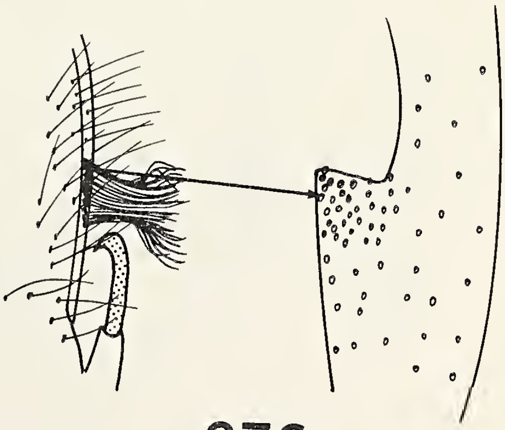

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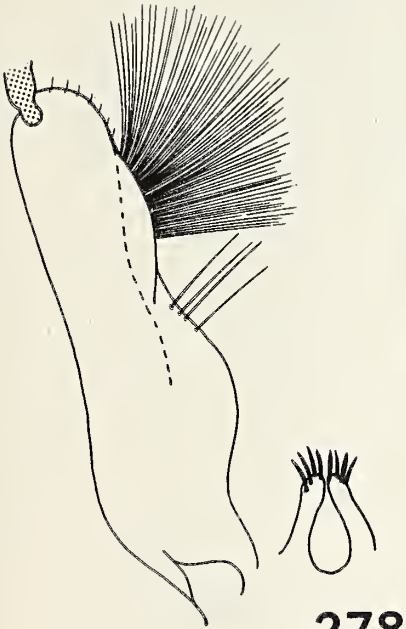
Plate XLVI

Figures 278–283. Male terminalia
278. *Aedes decticus*
279. *A. taeniorhynchus*
280. *A. mitchellae*
281. *A. aurifer*
282. *A. thibaulti*
283. *A. sollicitans*



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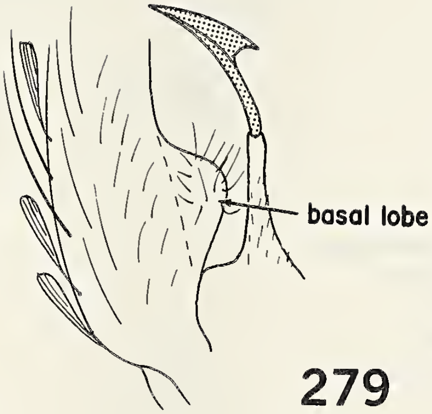

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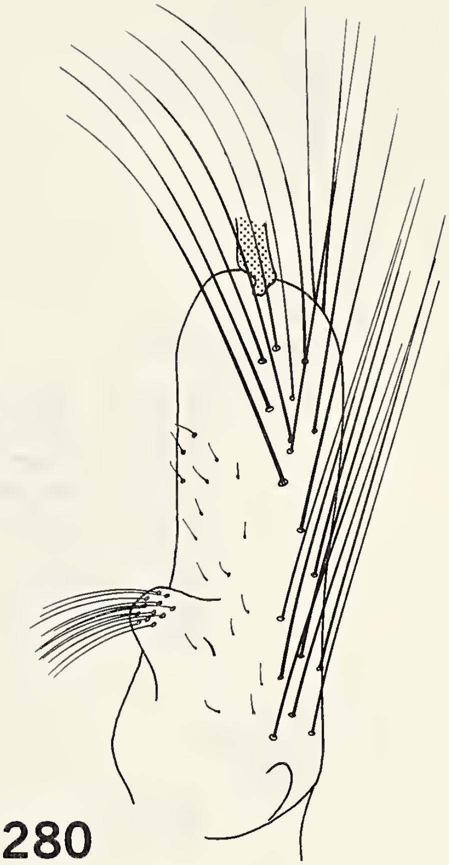

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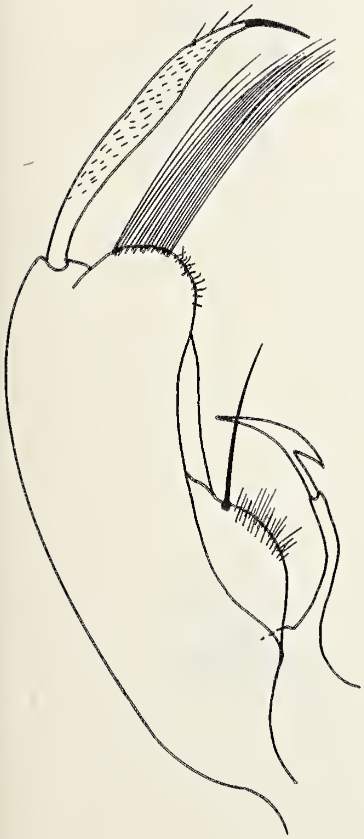

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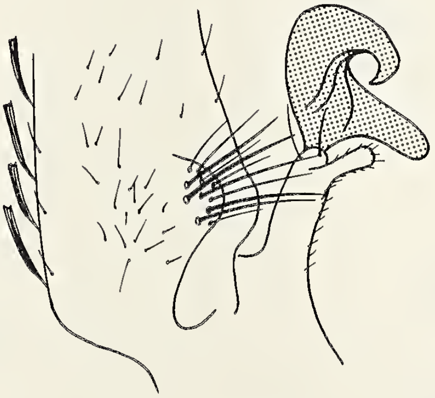

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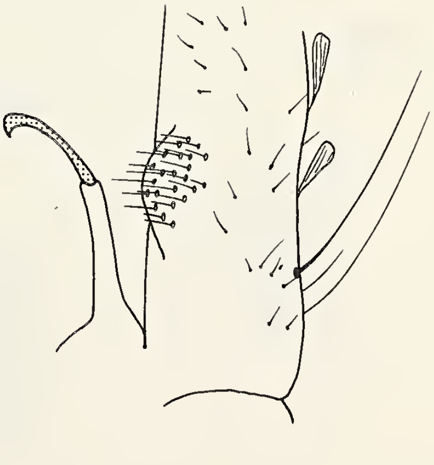
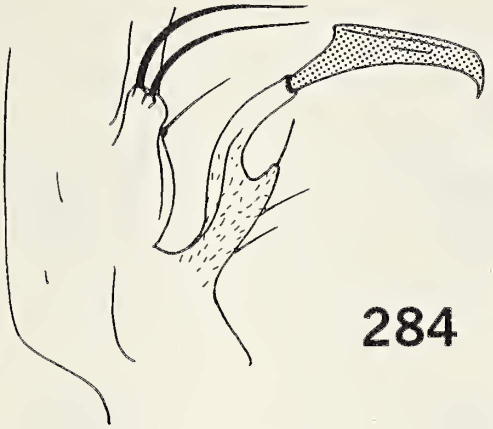


Plate XLVII

Figures 284–291. Male terminalia
284. *Aedes intrudens*
285. *A. trichurus*
286. *A. atlanticus*
287. *A. canadensis*
288. *A. dorsalis*
289. *A. sticticus*
290. *A. spencerii*
291. *A. excrucians*



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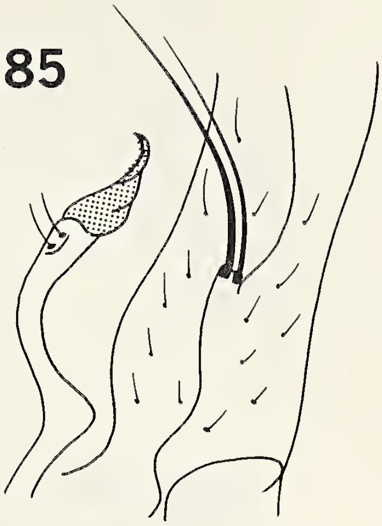

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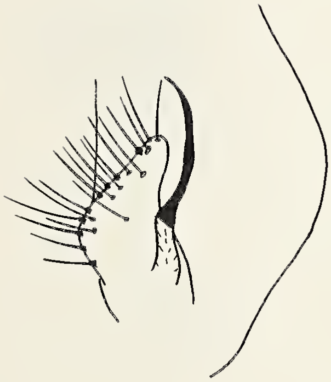

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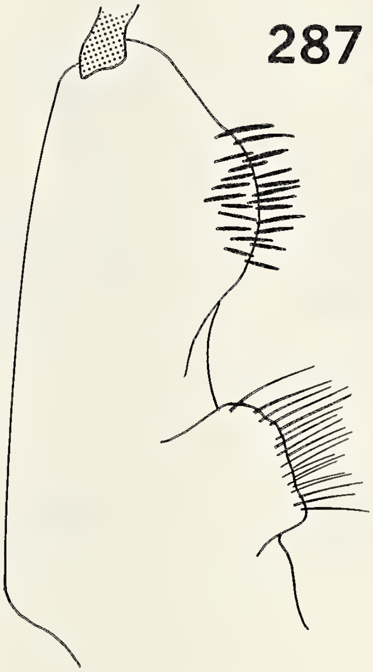

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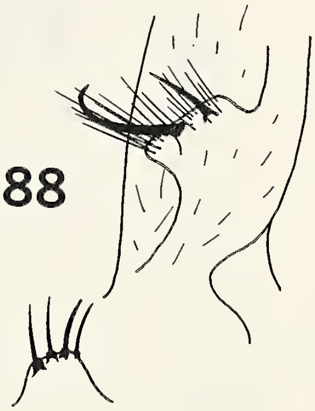

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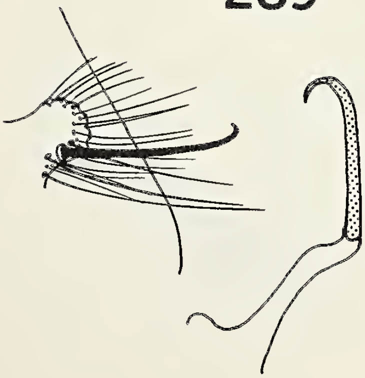

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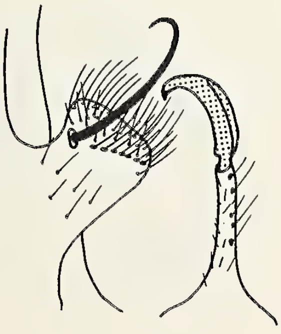

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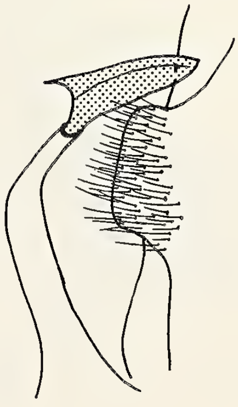
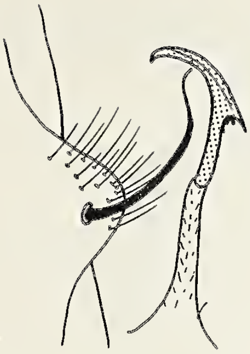


291

Plate XLVIII

Figures 292–301. Male terminalia
292. *Aedes trivittatus*
293. *A. stimulans*
294. *A. flavescens*
295. *A. grossbecki*
296. *A. cantator*
297. *A. abserratus*
298. *A. riparius*
299. *A. punctor*
300. *A. communis*
301. *A. fitchii*



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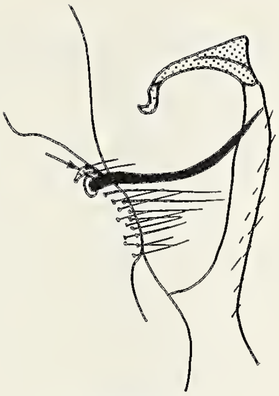

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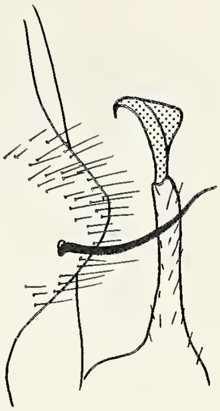

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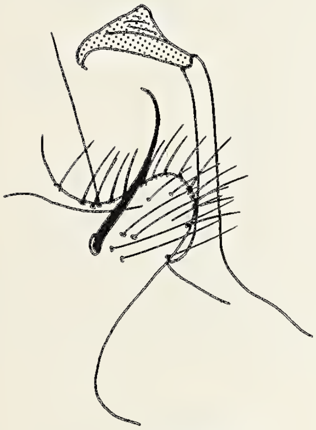

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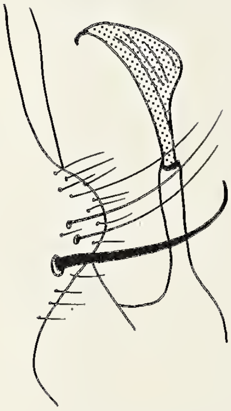

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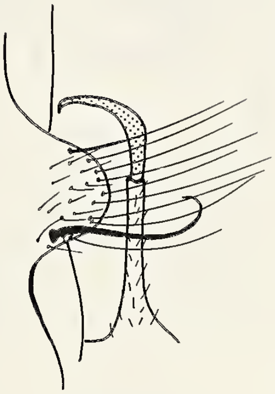

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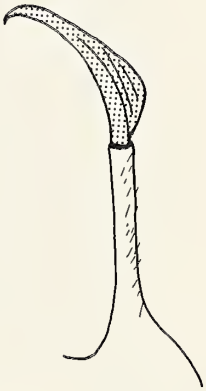

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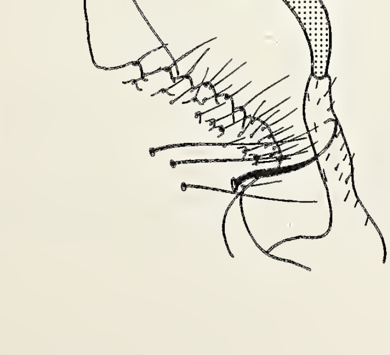

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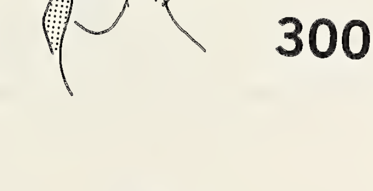

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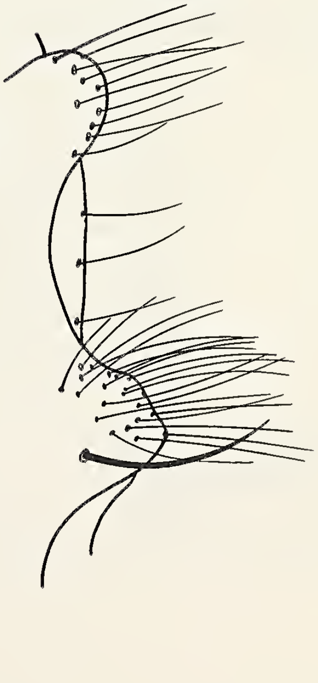
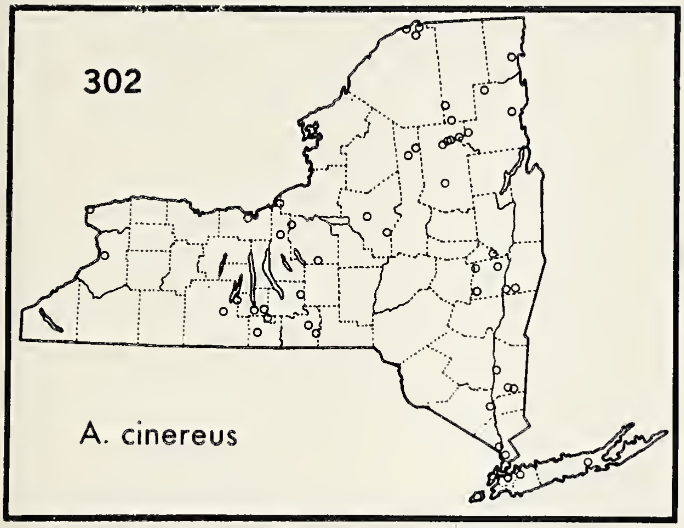


301

Plate IL. DISTRIBUTION MAPS

Figures 302. *Aedes cinereus*
303. *A. vexans*
304. *A. abserratus*
305. *A. atlanticus, A. atropalpus*
306. *A. aurifer*
307. *A. canadensis*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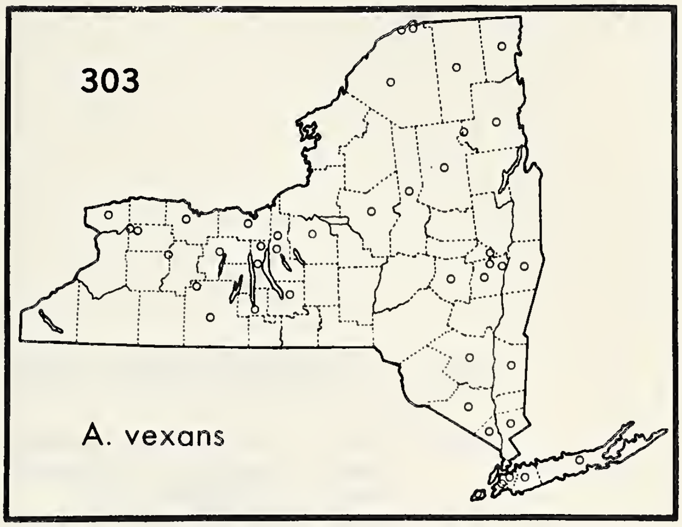
A. cinereus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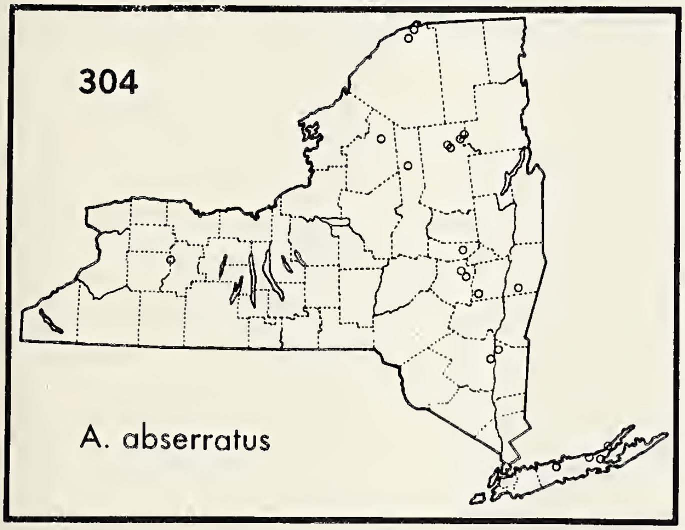
A. vexans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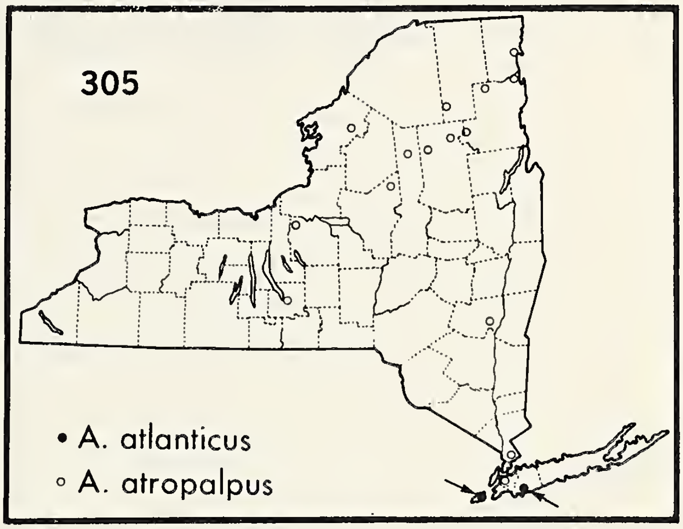
A. abserratus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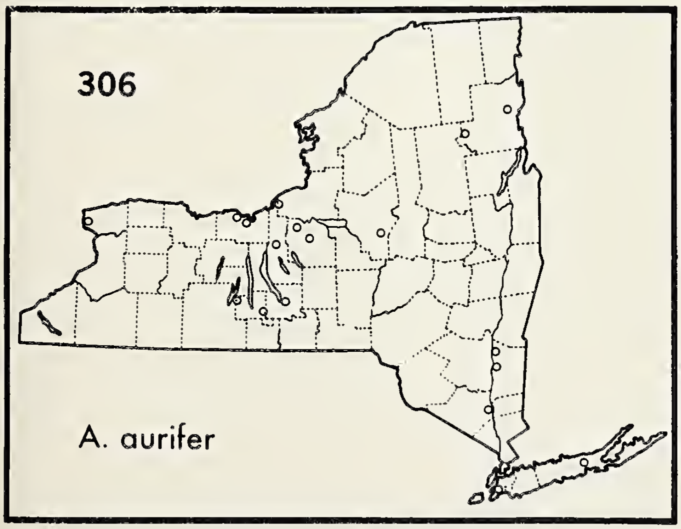
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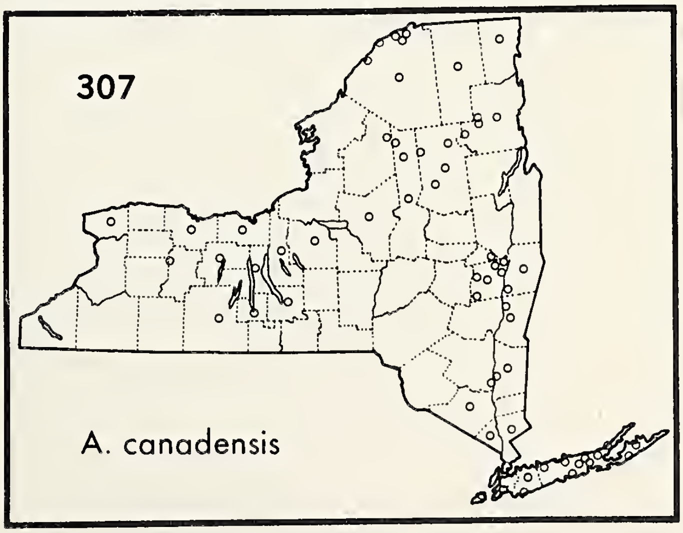
A. aurifer

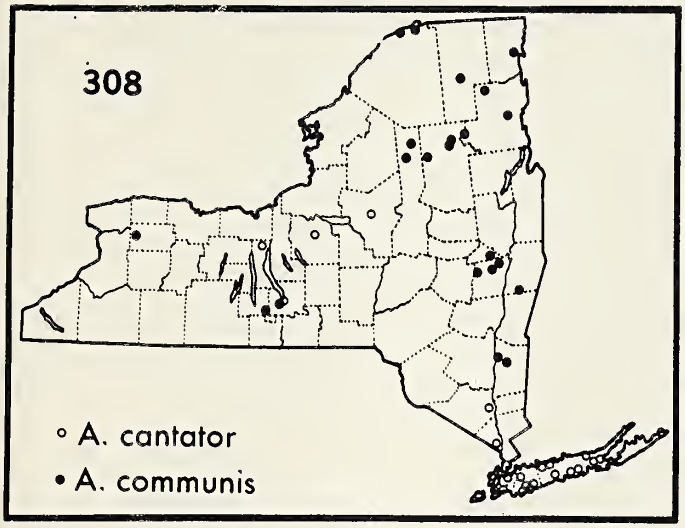

307

A. canadensis

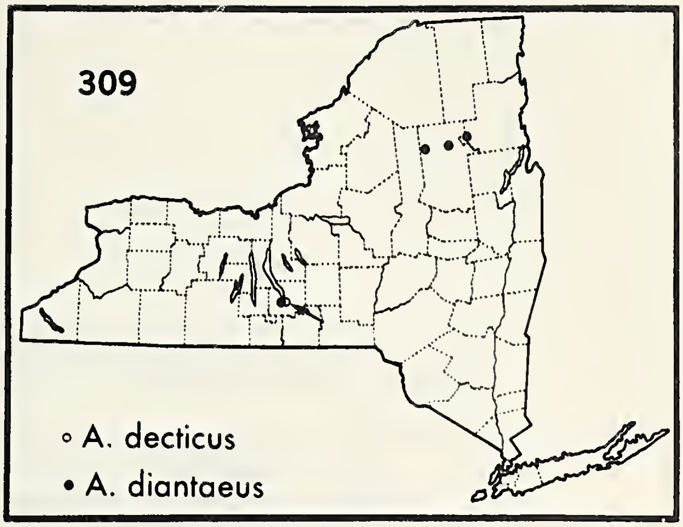
Plate L. DISTRIBUTION MAPS

Figures 308. ***A. cantator, A. communis***
309. ***A. decticus, A. diantaeus***
310. ***A. dorsalis***
311. ***A. excrucians***
312. ***A. fitchii***
313. ***A. flavescens, A. grossbecki***

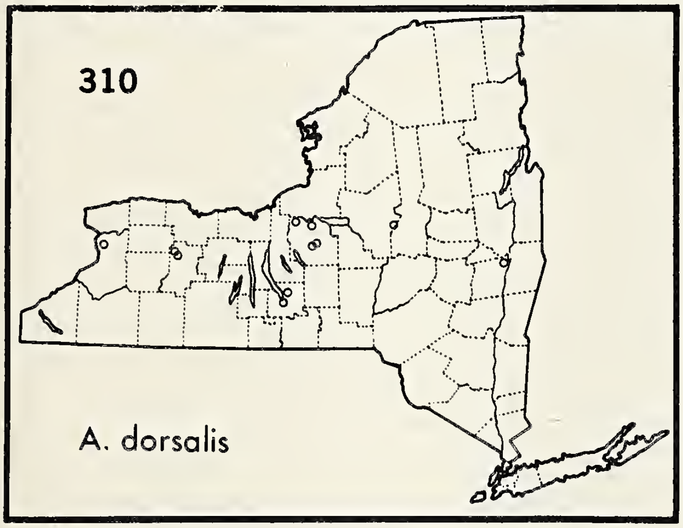
308


○ A. cantator
● A. communis

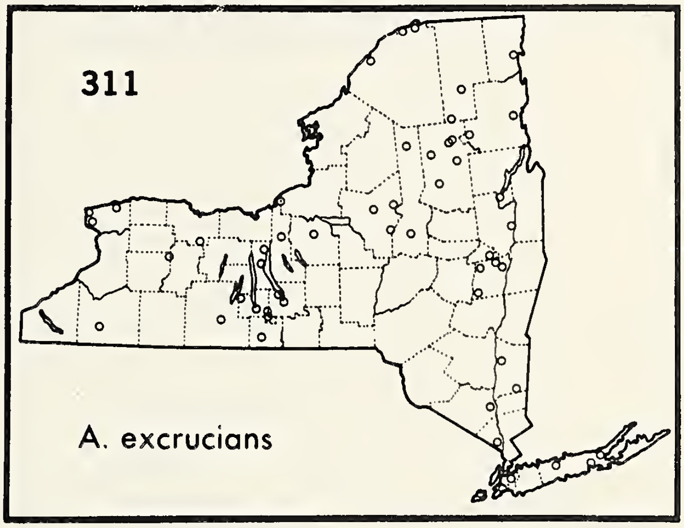
309


○ A. decticus
● A. diantaeus

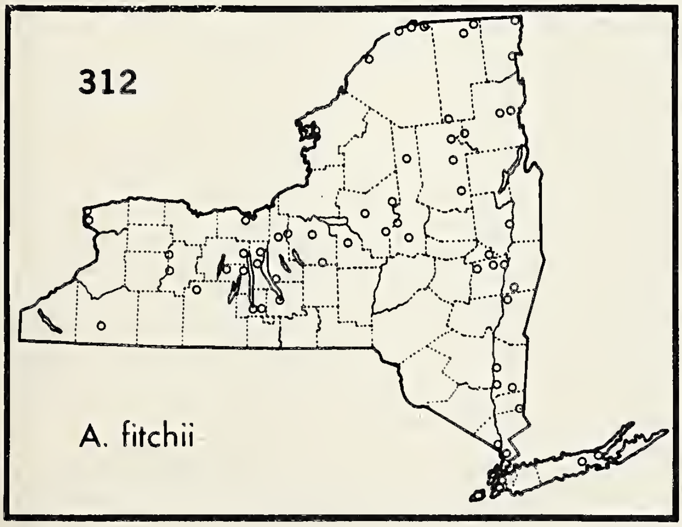
310


A. dorsalis

311


A. excrucians

312


A. fitchii

313

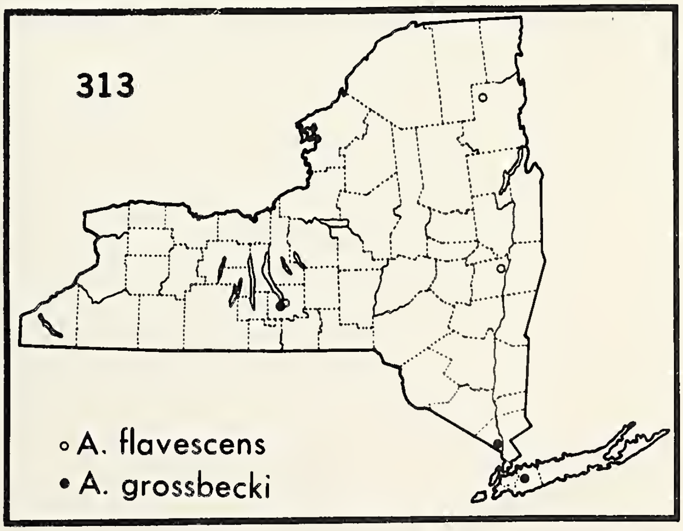
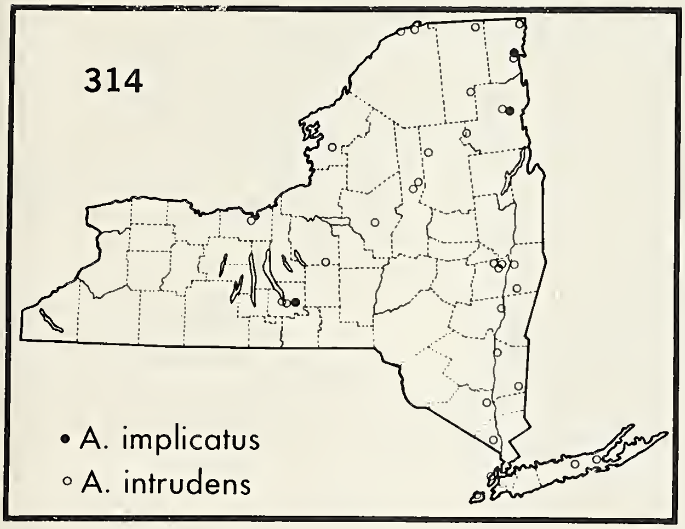

○ A. flavescens
● A. grossbecki

Plate LI. DISTRIBUTION MAPS

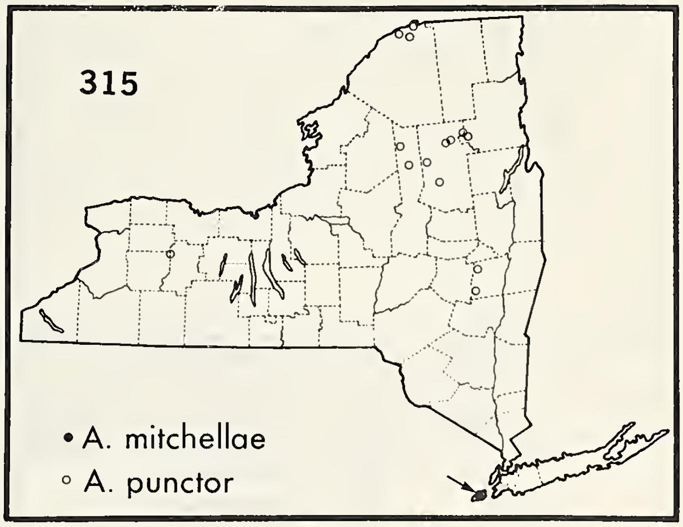
Figures 314. *A. implicatus, A. intrudens*
315. *A. mitchellae, A. punctor*
316. *A. riparius, A. sollicitans*
317. *A. spencerii, A. sticticus*
318. *A. stimulans*
319. *A. taeniorhynchus*

314



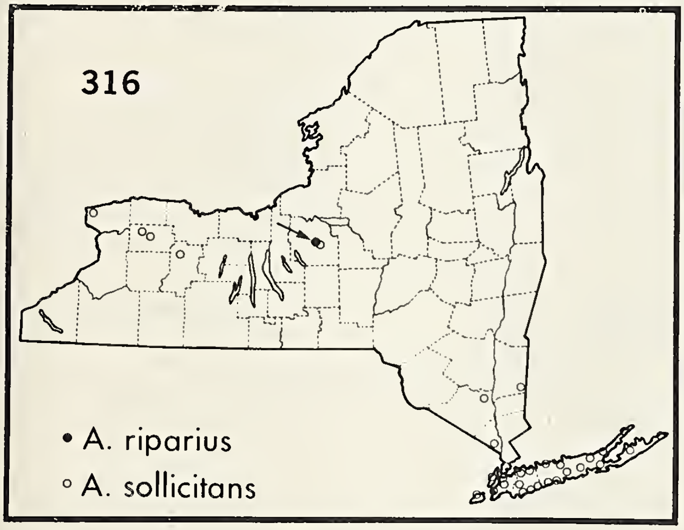
- ● A. implicatus
- ○ A. intrudens

315



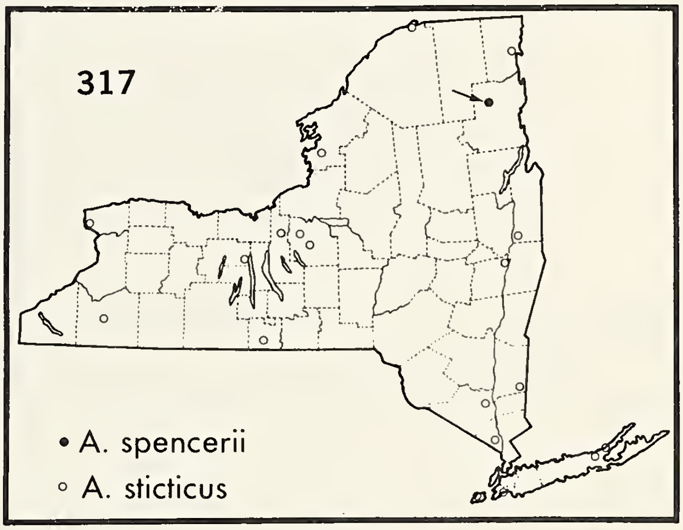
- ● A. mitchellae
- ○ A. punctor

316



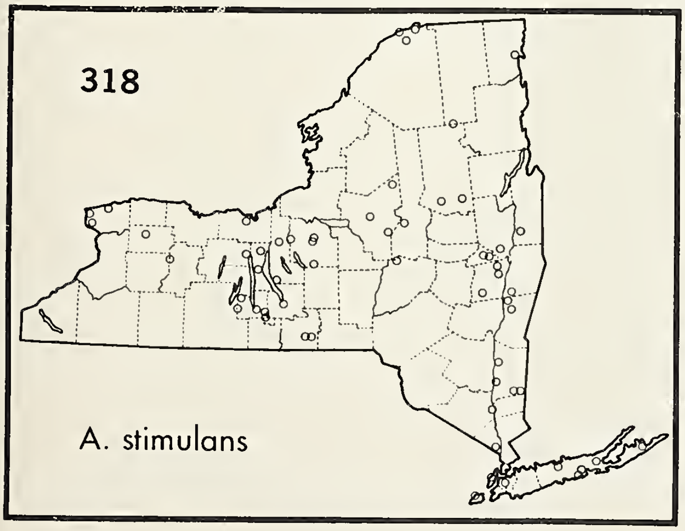
- ● A. riparius
- ○ A. sollicitans

317



- ● A. spencerii
- ○ A. sticticus

318



A. stimulans

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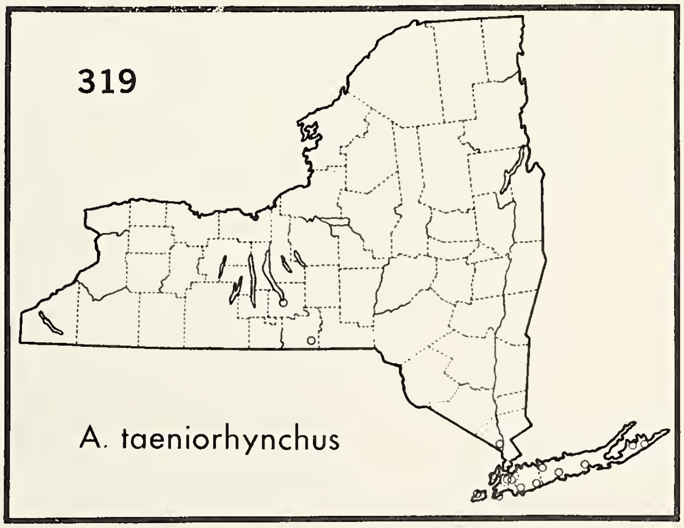

A. taeniorhynchus

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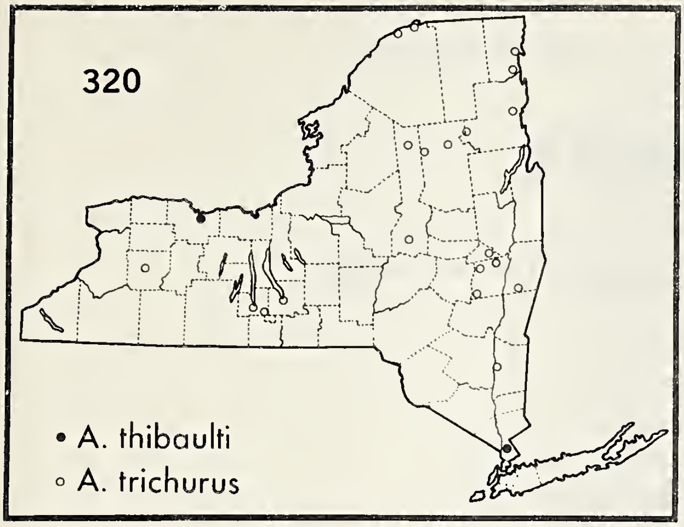
	322.	*A. triseriatus*
	323.	*A. hendersoni*



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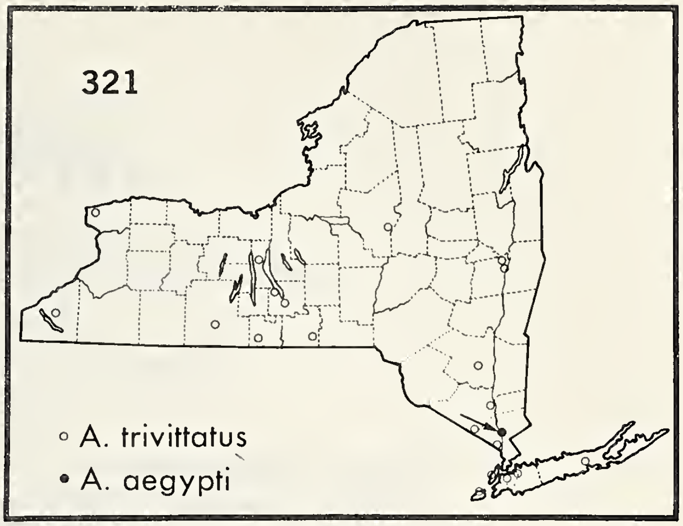
- ● A. thibaulti
- ○ A. trichurus



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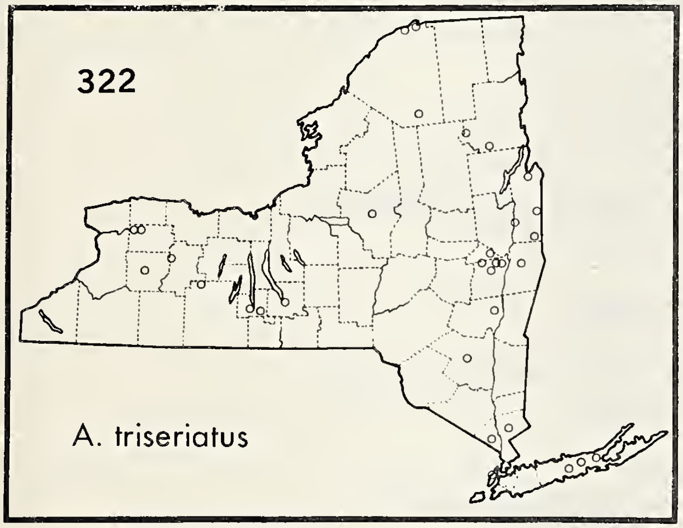
- ○ A. trivittatus
- ● A. aegypti



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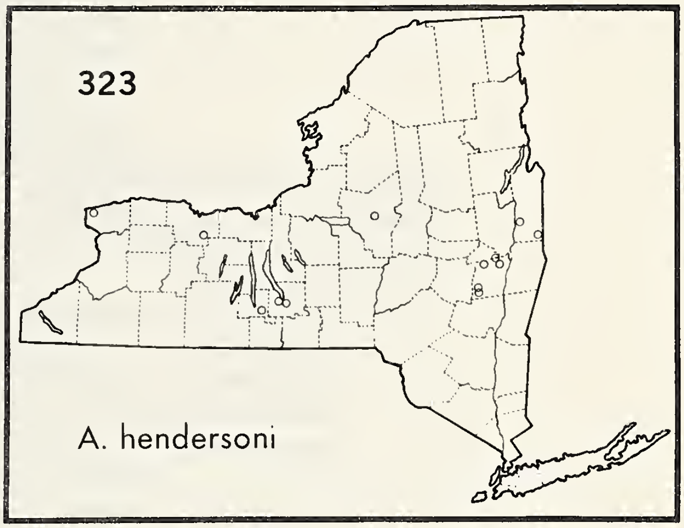
A. triseriatus



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A. hendersoni

APPENDIX

LIST OF MOSQUITOES (CULICIDAE) OF NEW YORK

Subfamily ANOPHELINAE
Anopheles (Anopheles) barberi Coquillett
bradleyi King*
crucians Wiedemann
earlei Vargas
punctipennis (Say)
quadrimaculatus Say
walkeri Theobald
Subfamily TOXORHYNCHITINAE
Toxorhynchites (Lynchiella) rutilus septentrionalis (Dyar & Knab)*
Subfamily CULICINAE
Tribe SABETHINI
Wyeomyia (Wyeomyia) smithii (Coquillett)
Tribe CULICINI
Coquillettidia (Coquillettidia) perturbans (Walker)
Uranotaenia sapphirina (Osten Sacken)
Orthopodomyia alba Walker*
signifera (Coquillett)*
Psorophora (Grabhamia) confinnis (Lynch Arribalzaga)*
(Janthinosoma) ferox Humboldt)
varipes (Coquillett)
(Psorophora) ciliata (Fabricius)
Aedes (Aedes) cinereus Meigen
(Aedimorphus) vexans (Meigen)
(Ochlerotatus) abserratus (Felt & Young)
atlanticus Dyar & Knab*
atropalpus (Coquillett)
aurifer (Coquillett)
canadensis (Theobald)
cantator (Coquillett)
communis (De Geer)
decticus Howard, Dyar & Knab*
diantaeus Howard, Dyar & Knab*
dorsalis (Meigen)
excrucians (Walker)
fitchii (Felt & Young)
flavescens (Müller)*
grossbecki Dyar & Knab*

---

* Rare in New York.

Aedes (Ochlerotatus) (continued)
implicatus Vockeroth*
intrudens Dyar
mitchellae Dyar*
riparius Dyar & Knab*
sollicitans (Walker)
spencerii (Theobald)*
sticticus (Meigen)
stimulans (Walker)
taeniorhynchus (Weidemann)*
thibaulti (Dyar & Knab)*
trichurus (Dyar)
trivattatus (Coquillett)
(Protomacleaya) hendersoni Cockerell
triseriatus (Say)
(Stegomyia) aegypti Linnaeus*
Culex (Culex) pipiens Linnaeus
restuans Theobald
salinarius Coquillett
(Neoculex) territans Walker
(Melanoconion) erraticus (Dyar & Knab)*
Culiseta (Climacura) melanura (Coquillett)
(Culicella) morsitans dyari (Coquillett)
silvestris minnesotae Barr*
(Culiseta) impatiens (Walker)
incidens (Thompson)*
inornata (Williston)

---

* Rare in New York.

COMMON AND SCIENTIFIC NAMES OF HOST ANIMALS REPORTED FOR MOSQUITOES OCCURRING IN NEW YORK[1]

Common Name	Scientific Name
CLASS MAMMALIA	
	Artiodactyla
Whitetail Deer	*Odocoileus virginianus* (Zimmerman)
	Carnivora
Black Bear	*Ursus americanus* Pallas
Red Fox	*Vulpes fulva* (Desmarest)
River Otter	*Lutra canadensis* Schreber
Raccoon	*Procyon lotor* (L.)
	Chiroptera
Little Brown Bat	*Myotis lucifugus* Le Conte
	Lagomorpha
Domestic Rabbit	*Oryctolagus cuniculus domestica* L.
Eastern Cottontail	*Sylvilagus floridanus* (Allen)
New England Cottontail	*Sylvilagus transitionalis* Bangs
	Marsupalia
Opossum	*Didelphis marsupialis* L.
	Rodentia
Woodchuck	*Marmota monax* (L.)
Thirteen-lined Ground Squirrel	*Citellus tridecimlineatus* (Mitchill)
Red Squirrel	*Tamiasciurus hudsonicus* Erxleben
Eastern Gray Squirrel	*Sciurus carolinensis* Gmelin
Fox Squirrel	*Sciurus niger* L.
Eastern Chipmunk	*Tamias striatus* (L.)
Beaver	*Castor canadensis* Kuhl
Meadow Vole	*Microtus pennsylvanicus* Ord
Red-backed Vole	*Clethrionomys gapperi* Vigors
White-footed Mouse	*Peromyscus leucopus* Rafinesque
Norway Rat	*Rattus norvegicus* Berkenhout
Porcupine	*Erithizon dorsatum* L.
Muskrat	*Ondatra zibetica* L.
CLASS AMPHIBIA	
	Anura
Bullfrog	*Rana catesbiana* Shaw
Green Frog	*Rana clamitans* Latreille
Leopard Frog	*Rana pipiens* Schreiber

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[1] Conant, R. and I.H. Conant. 1975. A field guide to reptiles and amphibians of eastern and central North America, second ed. Boston, Houghton Mifflin. 429 p.

Blair, W.F., A.P. Blair, P. Brodkorb, F.R. Cagle and G.A. Moore. 1957. Vertebrates of the United States, second ed. New York, McGraw-Hill. 616 p.

CLASS AVES

	Accipitriformes
Turkey Vulture	*Cathartes aura* (L.)
	Anseriformes
Mallard	*Anas platyrhynchos* L.
White Pekin Duck	*Anas platyrhynchos* L. (domestic var.)
Canada Goose	*Branta canadensis* L.
	Ardriformes
Common Egret	*Egretta alba* (L.)
	Charadriformes
Woodcock	*Philohela minor* (Gmelin)
	Columbiformes
Domestic Pigeon	*Columba livia* Gmelin
	Galliformes
Bobwhite	*Colinus virginianus* (L.)
Chicken	*Gallus gallus* L.
Ring-necked Pheasant	*Phasianus colchicus* L.
Ruffed Grouse	*Bonasa umbellus* (L.)
	Passeriformes
Blue Jay	*Cyanocitta cristata* (L.)
Catbird	*Dumatella carolinensis* (L.)
Common Grackle	*Quiscalus quiscula* (L.)
Common Raven	*Corvus corax* L.
House Sparrow	*Passer domesticus* (L.)
White-throated Sparrow	*Zonotrichia albicollis* (Gmelin)
Rufous-sided Towhee	*Pipilo erythrophthalmus* (L.)
Red-winged Blackbird	*Agelaius phoeniceus* (L.)
Starling	*Sturnus vulgaris* L.
	Strigiformes
Barn Owl	*Tyto alba* (Scopoki)

CLASS REPTILIA

	Chelonia
Eastern Box Turtle	*Terrepene carolina* (L.)
Eastern Painted Turtle	*Chrysemys picta picta* (Schneider)
Western Painted Turtle	*Chrysemys picta belli* (Schneider)
Eastern Spotted Turtle	*Clemmys guttata* (Schneider)
Snapping Turtle	*Chelydra serpentina* L.
Blanding's Turtle	*Emydoidea* blandingi (Holbrook)
	Squamata
	Serpentes
Kingsnake	*Lampropeltis getulus* L.
Northern Black Racer (Blacksnake)	*Coluber constrictor constrictor* L.
Northern Water Snake	*Natrix sipedon sipedon* (L.)
Eastern Garter Snake	*Thamnophis sirtalis sirtalis* (L.)
Fox Snake	*Elaphe vulpina* (Baird & Girard)

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[1] An asterisk (*) indicates a synonym.

[2] Genus in parentheses( ) indicates genus of original description.

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MOSQUITOES OF NEW YORK

art II. Genera of Culicidae other than *Aedes* Occurring in New York

Robert G. Means
Senior Scientist, Entomology

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DEDICATION

This publication is dedicated to Dr. Marion E. Smith with admiration and appreciation for the many years she devoted to mosquito systematics and to her students of Culicidology

ABSTRACT

This is the second volume of a two-part series which brings together systematically for the first time since 1904 much information regarding the mosquitoes of New York. "Mosquitoes of New York. Part I. The Genus *Aedes* meigen with identification keys to genera of Culicidae" was published in 1979; the present volume treats the other genera known from New York. Keys for the identification of adult females, males and fourth instar larvae of the mosquito genera and of New York species of *Anopheles, Psorophora, Culex, Culiseta, Coquillettidia, Orthopodomyia, Wyeomyia, Uranotaenia* and *Toxorhynchites* are presented. Thirty-two species are reviewed, summarized, keyed and illustrated. Species treatment includes synonymy, descriptions of adults and immature stages, bionomics, distribution, disease relationships and pertinent literature. General information on reduction of mosquito populations through cultural, biological and chemical means is discussed. Two hundred and three figures are included.

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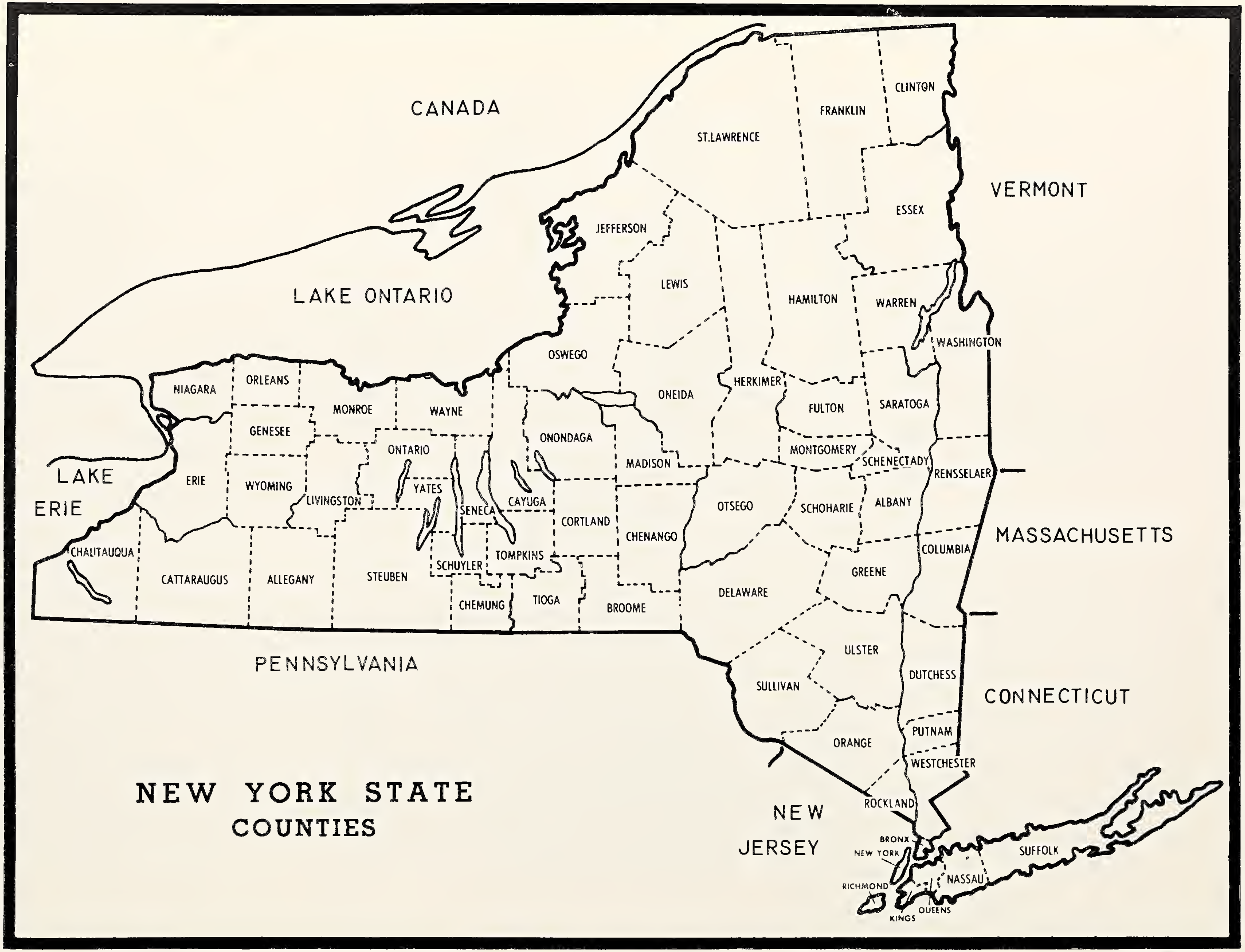
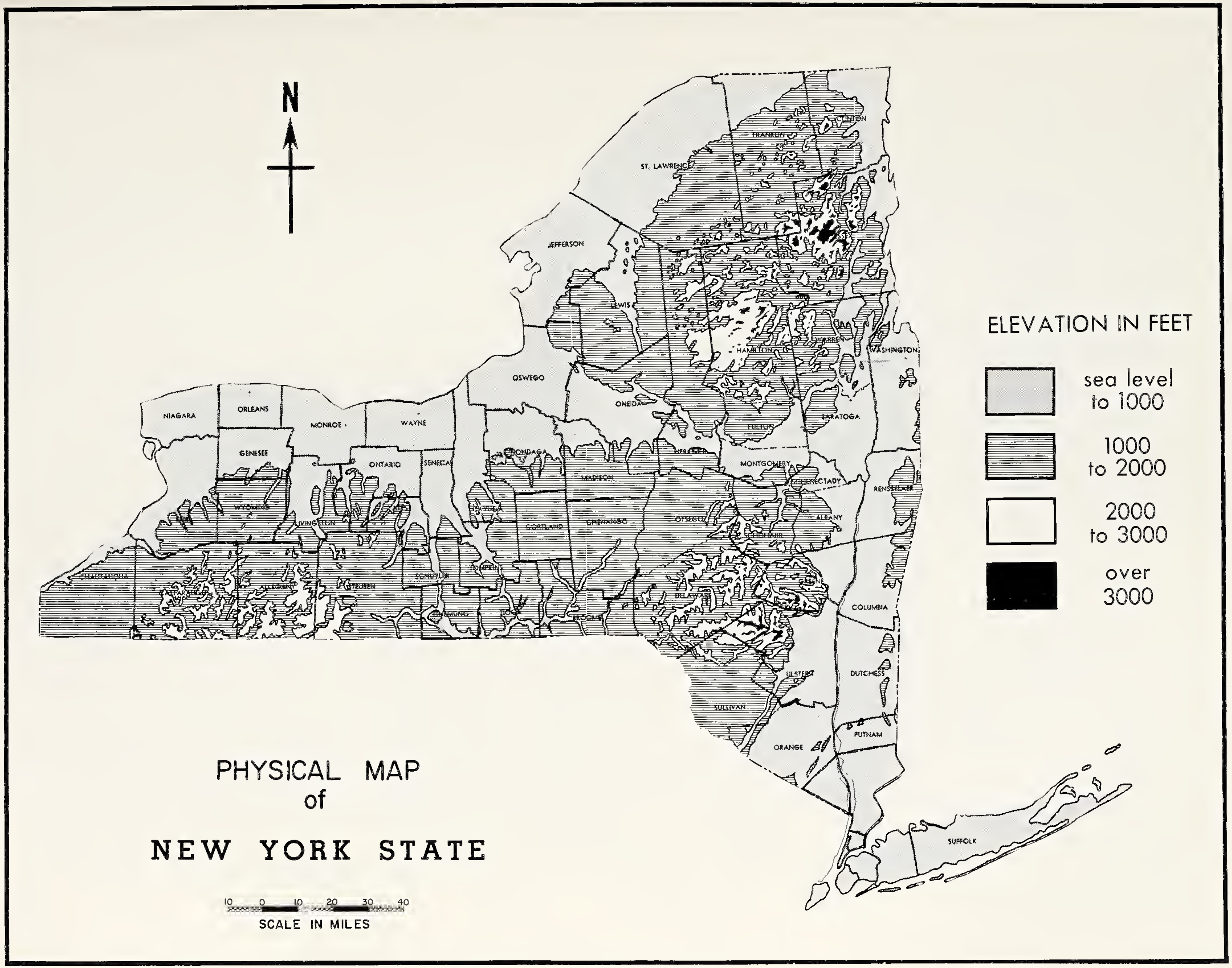


Figure 1. Counties of New York State



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From Susruta, Sanskrit passages written between 1000 BC and 600 AD:

तुङ्गीनासो विचिलकस्तालको वाहकस्तथा ।
कोष्ठागारी क्रिमिकरो यश्च मण्डलपुच्छकः ॥
तुङ्गनाभः सर्षपिकोऽवल्गुली शम्बुकस्तथा ।
अग्निकीटश्च घोराः स्युर्द्वादश प्राणनाशनाः ॥
तैर्भवन्तीह दष्टानां वेगज्ञानानि सर्पवत्
तास्ताश्च वेदनास्तीव्रारोगा वै सान्निपातिकाः ॥
क्षाराग्निदग्धवद्दंशो रक्तपीतसितारुणः ।
ज्वराङ्गमर्दरोमाञ्चवेदनाभिः समन्वितः ॥
छर्द्यतीसारतृष्णा च दाहो मोहविजृम्भिका ॥
वेपथुश्वासहिक्काश्च दाहः शीतञ्च दारुणम् ॥
पिडकोपचयः शोफो ग्रन्थयो मण्डलानि च ।

Translation

". . . Their bite is as painful as that of serpents, and causes diseases resulting from the three humours joined together; the bite, as if burnt with caustic or fire, is red, yellow, white and pink colour, accompanied by fever, pain of limbs, hair standing on end, pain, vomiting, diarrhoea, thirst, heat, giddiness, yawning, shivering, hiccup, burning sensation, intense cold, vesicles or pustules increasing, swelling, knots under the skin, circles, etc."

मशकाः सामुद्रः परिमण्डलो हस्तिमशकः कृष्णः पार्व्वतीय इति पञ्च । तैर्दष्टस्य तीव्रकण्डूर्दंशशोफश्च । पार्व्वतीयस्तु कीटैः प्राणहरैस्तुल्यलक्षणः ॥

Translation

"Masakah (Mosquitoes) are of five kinds: Samudra, Parimandala, Hastimasaka, Krishna, Parwatiya. Their bite causes swelling on the part bitten, itching. As for the Parwatiya, it has similar qualities to life-taking insects."

From Blake, Sir Henry A., 1905, "Ancient Theories of Causation of Fever by Mosquitoes" (Russell, 1955).

Mosquitoes of New York, Part II[1]

INTRODUCTION

Since the manuscript for *Mosquitoes of New York, Part I* (Means, 1979) was completed, classification of the mosquitoes has been revised (Knight and Stone, 1977; Knight, 1978; Ward, 1984). The present publication follows this revised classification, which recognizes three subfamilies, Anophelinae, Culicinae and Toxorhynchitinae.

The subfamily Anophelinae contains three genera and 447 species, subspecies and varieties, represented in New York State by the genus *Anopheles* and six (possibly seven or eight) species. The subfamily Toxorhynchitinae contains the single genus, *Toxorhynchites*, with 71 species and subspecies, and is represented in New York State by one subspecies. The subfamily Culicinae contains 10 tribes with a total of 33 genera and 2753 species, subspecies and varieties. Of these, 7 tribes with 8 genera and 57 species, subspecies and varieties have been reported from New York State or neighboring states.

In *Part I*, keys were included to identify first instar larvae; second, third and fourth instar larvae; pupae; adult females and adult males for the mosquito genera occurring in New York and for the New York species of the genus *Aedes* (subfamily Culicinae). A similar treatment for the New York species in genera other than *Aedes* had been planned for Part II. However, because many discrepancies and considerable variation were found in labeled specimens of first instar larvae from various collections and few confirmed specimens were available, it was felt that key characters may not be reliable. Therefore, keys to this stage are not included. Plates IV and V are included to illustrate the general morphology of first instar larvae.

Likewise, although specimens of second and third instar larvae of *Aedes* were available for inclusion in the key to larvae in Volume I, few confirmed specimens were available for other genera. Because there was considerable variation in the specimens which were available, the author felt it was inadvisable to attempt to include them in the present keys. Also, because of variations within a species, and subsequent uncertainty in identifying early instar larvae, it is preferable to make larval identifications only from fourth instar specimens, even if this necessitates rearing earlier instar larvae to fourth instar.

As with first instar larvae, many discrepancies were noted among labeled pupal specimens from various collections, and few confirmed pupal specimens were available for study. It is important to note that fresh pupal exuviae, rather than whole pupae, are necessary for identification. Therefore, it is usually necessary to rear live specimens until they emerge as adults in order to obtain the exuviae. Additionally, either fourth instar larvae or adult specimens are nearly always more useful for identification of mosquitoes than are pupae, and the latter should not be depended upon for identification except in unusual circumstances. Since the purpose of this publication is to provide the most reliable and efficient means of identification of mosquitoes, and because the author was unable to obtain pupal exuviae with confirmed identifications for many of the species treated in the present volume, keys to pupae are not included. Figure 42 is included to indicate the general structure and chaetotaxy of a pupa. The reader is referred to Barr (1963), Barr and Barr (1969), Barr and Myers (1962), Belkin (1952, 1953, 1962) and Darsie (1951) for additional information on pupal identification.

In the species diagnosis sections for adult females, and occasionally in keys, relative size is used as a recognition character (small, medium, large). The body of an adult mosquito is often misshapen or broken, making it difficult or impossible to accurately measure. The wings, however, are nearly always complete and straight, making them a more accurate method of measurement. Therefore, in addition to the relative size discussed above, wing length is given in the diagnosis for each species, ranging from approximately 2.0 mm for *Uranotaenia sapphirina* to 7.0 mm for *Toxorhynchites rutilus septentrionalis*.

Part II includes keys to the New York species of *Anopheles*, *Psorophora*, *Culex*, *Culiseta*, *Wyeomyia* and *Orthopodomyia* as fourth instar larvae, adult females and adult males. Also included are brief synopses and discussions of the bionomics, distribution and importance of each of these species as well as the single New York species of the genera *Coquillettidia* and *Toxorhynchites*. The "types" of life cycles discussed in the bionomics of some of the species refer to categories described by Pratt (1959), which are summarized in *Mosquitoes of New York, Part I.* The terminology and morphological structures referred to in the keys and synopses have been discussed in *Part I*, but figures 40 and 41 are included in *Part II* to illustrate setal positions and structures of larvae. The terminology employed for morphological structures in this volume is that of Horback & Knight (1980), now used in virtually all publications on mosquito systematics. Where appropriate in keys and in figures these more modern morphological terms are followed by the corresponding terms which were employed in Volume I.

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[1] Manuscript submitted for publication, April 30, 1983.

To avoid confusion among workers in mosquito taxonomy, this publication employs the two-letter abbreviations for mosquito genera proposed by Reinert (1975) which are now in common usage. It is recognized, however, that such two-letter abbreviations may not be in keeping with the rules of nomenclature established by the International Committee of Zoological Nomenclature.

Most of the distribution records contained herein were obtained from the collections of Cornell University, Ithaca, New York; New York State Museum, Albany, New York; American Museum of Natural History, New York, New York; U. S. National Museum, Washington, D. C.; Suffolk County Bureau of Vector Control, Yaphank, New York and Vector Control Division, Ulster County Department of Health, Kingston, New York.

IDENTIFICATION KEYS TO NEW YORK GENERA OF THE FAMILY CULICIDAE

Keys to the genera occurring in New York of females, males and fourth instar larvae, although included in *Mosquitoes of New York, Part I*, are repeated here for the convenience of the reader.

FEMALES

1. Wing cell R_2 (second marginal) not more than half the length of vein R^{2+3} (petiole); wing alula (squama) without fringe of hairs (fig. 190) 2
   Wing cell R_2 at least the length of vein R^{2+3}; alula with or without fringe of hairs 3
2. Proboscis tapered and curved abruptly downward, maxillary palpus long and massive (fig. 193); wing length 6.5 mm or more; very large species with broad, metallic-colored scales on head, thorax and abdomen . . . . *Toxorhynchites*
   Proboscis only slightly curved, maxillary palpus short; wings less than 3.5 mm long; small species with groups of highly iridescent blue scales on mesonotum and thoracic pleura . . . . . . *Uranotaenia*
3. Scutellum smoothly rounded with setae arranged evenly around it (fig. 73); maxillary palpus nearly as long as proboscis (fig. 64); abdomen without scales or only sparsely scaled . . . . *Anopheles*
   Posterior margin of scutellum trilobed, with setae grouped on these lobes (figs. 86-89); abdomen densely scaled dorsally and ventrally 4
4. Postnotum with tuft of setae (fig. 186); alula without fringe of hairs; abdomen with dark scales dorsally and pale scales ventrally, meeting laterally in straight line (fig. 185) . . . . *Wyeomyia*
   Postnotum bare; alula with fringe of hairs (fig. 101); abdominal tergites banded or with lateral spots (figs. 131-135) 5
5. Prespiracular setae (spiracular bristles) present (fig. 157) 6
   Prespiracular setae absent 7
6. Postspiracular setae present (fig. 92); tip of abdomen pointed as viewed from above; cerci usually conspicuous (fig. 91); base of subcosta without tuft on underside . . . . *Psorophora*
   Postspiracular setae absent; tip of abdomen bluntly rounded as viewed from above; cerci inconspicuous or concealed (fig. 155); base of subcosta with tuft of setae ventrally (fig. 161) . . . . *Culiseta*
7. Postspiracular setae present (fig. 92); tip of abdomen pointed when viewed from above; cerci usually conspicuous (fig. 91) . . . . *Aedes*
   Postspiracular setae absent; tip of abdomen rounded; cerci inconspicuous or concealed (fig. 131) 8
8. Wing scales narrow, uniformly dark (fig. 125) . . . . *Culex*
   Wing scales broad, conspicuously dark and light intermixed (fig. 181) 9
9. Hindtarsus with some segments banded on both ends; mesonotum dark, with fine lines of sharply contrasting white scales forming a distinctive pattern (fig. 180) . . . . *Orthopodomyia*
   First hindtarsal segment banded basally and medially, other segments banded basally only (fig. 170); mesonotum with intermixed dark brown and golden scales . . . . *Coquillettidia*

MALES[2]

1. Gonocoxite (basistyle) with one or two stout spines near base; phallosome 4 or more times longer than wide, often with leaflets at tip (fig. 201) . . . . *Anopheles*
   Gonocoxite without basal spines; phallosome less than 4 times longer than wide, without leaflets at tip 2
2. Claspettes present (pl. XIX) 3
   Claspettes absent 4
3. Gonostylus (dististyle) strongly swollen (rarely lobate), or bowed inward, or both (pl. XIX) . . . . *Psorophora*
   Gonostylus not strongly swollen; straight or bowed outward (fig. 202) . . . . *Aedes* (except *aegypti*)

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[2] Adapted from Scott (1961)

4. Tergum X (tenth sternite) with comb of teeth or crowned with tuft of spines (pl. XXVI) . . . . *Culex*
   Tergum X simple or with few apical teeth 5
5. Gonostylus with three or more branches (fig. 199) . . . . *Wyeomyia*
   Gonostylus simple or with a single lobe near base 6
6. Phallosome platelike, with one or more large teeth on each side (fig. 198) . . . . *Uranotaenia*
   Phallosome subconical, often with small teeth near tip 7
7. Basal mesal lobe (basal lobe) of gonocoxite with 1 or 2 rods at apex, few or no setae (fig. 197) . . . . *Coquillettidia*
   Basal mesal lobe of gonocoxite with spines, or numerous small setae 8
8. Gonostylar claw comblike (fig. 200) . . . . *Orthopodomyia*
   Gonostylar claw spinelike 9
9. Outer edge of gonocoxite with large scales (fig. 195) 10
   Outer edge of gonocoxite without large scales . . . . *Culiseta*
10. Gonostylus cylindrical, with subapical spine (fig. 195) . . . . *Toxorhynchites*
    Gonostylus tapering, with apical spine (fig. 203) . . . . *Aedes aegypti*

IDENTIFICATION OF LARVAL INSTARS

Certain morphological characteristics are consistent and useful for species identification of fourth instar larvae. However, these same characteristics are often not present in earlier developmental stages, i.e. first, second or third instar. Before species identification can be made, therefore, it is first necessary to determine which developmental stage a larva is in.

First instar larvae are easily recognized by: 1) the presence of a median pointed or transverse ridge (egg buster) on the vertex of the head capsule, or 2) lack of a ventral brush on abdominal segment X (anal segment), and 3) lack of a cratal seta, 4-X (Dodge, 1966; Means, 1979; Savignac and Maire, 1981). In addition, most non-anopheline species have a bicolored siphon with two distinct sclerotized areas in the first instar.

Second and third instar culicine larvae differ from fourth instar in having the saddle of abdominal segment X incomplete (not meeting ventrally) and with the ventral corners rounded, whereas fourth instar larvae either have the saddle complete, or, if incomplete, with the ventral corners angulate. Fourth instar anopheline species have a large dark area representing the eye of the adult anterior to the compound eye of the larva, not present on second and third instars.

Smith (1965b, 1969a,b); MacKenzie (1966); Savignac and Maire (1981) and others found consistent chaetotaxic differences between instars II and III of many culicid species. Several, and maybe all, species in the genera *Aedes*, *Anopheles*, *Culex*, *Culiseta*, *Toxorhynchites*, *Wyeomyia* and *Orthopodomyia* have a tubercle bearing a multiple seta (7) present on the metathorax in instar III which is absent in instar II. A second tubercle bearing setae 9, 10, 11, and 12 is present in both instars.

INSTARS OF MOSQUITO LARVAE

1. Siphon present (Culicinae and Toxorhynchitinae) 2
   Siphon absent (Anophelinae) 6
2. Siphon conspicuously bicolored, tipped with black (fig. 48) (except *Coquillettidia*, which is curved and attenuated in all instars (fig. 167); head with point or ridge (egg buster) on vertex (fig. 43) . . . . First Instar
   Siphon uniformly colored, or nearly so; head without egg buster 3
3. One tubercle bearing a hair tuft on each side of metathorax (fig. 46) . . . . Second Instar
   Two tubercles bearing hair tufts on each side of metathorax (fig. 47) 4
4. Saddle complete (surrounding segment X) (pl. XIV) . . . . Fourth Instar (pars)
   Saddle incomplete (sides not meeting ventrally) 5
5. Saddle hair inserted on saddle closer to posterior margin than to ventral margin, or to extension of ventral margin if saddle is incised posteriorly; saddle viewed laterally usually quadrangular, with angular ventral corners; pupal seta 1-I (float hair) sometimes visible beneath exoskeleton. . . . . Fourth Instar (pars)
   Saddle hair inserted on membrane below saddle, or, if on saddle, closer to ventral margin than to posterior margin (rarely equidistant); ventral margin of saddle rounded, without distinct ventral corners; hairs of fourth instar, but not pupal seta 1-I, sometimes visible beneath exoskeleton (fig. 50) . . . . Third Instar
6. Head with egg buster on vertex . . . . . First Instar
   Head without egg buster (fig. 53, 54) 7
7. Seta 7-MX (palp hair) absent (fig. 53) . . . . Second Instar
   Seta 7-MX present (fig. 54) 8
8. Large, dark area representing eye of adult present, anterior to compound eye of larva . . Fourth Instar
   Dark area representing eye of adult absent (fig. 54) . . . . Third Instar

FOURTH INSTAR LARVAE

1. Eighth abdominal segment without elongate siphon; some abdominal segments with palmate hairs dorsally (seta 1) (fig. 40) . . . .*Anopheles*
   Siphon present (fig. 41); abdominal segments without palmate hairs 2
2. Eighth abdominal segment without comb scales, but bearing 2 long, barbed spines and 2 small, branched setae on large sclerotized plate (fig. 192); abdominal segments III-VII each with 3 pairs of lateral plates bearing long, spine-like setae . . . .*Toxorhynchites*
   Eighth abdominal segment with comb scales (fig. 41), without long, barbed spines, with or without sclerotized plates; abdominal segments without lateral plates bearing spine-like setae, with or without dorsal sclerotized plates 3
3. Eighth abdominal segment with large sclerotized plate bearing a row of comb scales along posterior margin (fig. 187); head longer than wide; head hairs 5 and 6 single, peglike (fig. 188) . . . . *Uranotaenia*
   Eighth abdominal segment without sclerotized plate; head wider than long; head hairs 5 and 6 slender 4
4. Siphon with pecten (fig. 41) 5
   Siphon without pecten .8
5. Siphon with a pair of branched setae near base (pl. XXVIII) . . . .*Culiseta*
   Siphon without branched setae near base 6
6. Siphon with several pairs of ventral setae (pl. XXII) . . . .*Culex*
   Siphon with no more than one pair of ventral setae, but sometimes (*Aedes provocans*, formerly *trichurus*) with several pairs of branched setae dorsad of pecten 7
7. Segment X (anal segment) completely ringed by saddle, pierced on ventral side by tufts of ventral brush (pl. XIV) . . . .*Psorophora*
   Saddle incomplete, or if complete, not pierced by tufts of ventral brush . . . .*Aedes*
8. Siphon short, pointed, with teeth along one side (fig. 167) . . . .*Coquillettidia*
   Siphon elongate, at least twice as long as wide; not pointed and without teeth 9
9. Siphon with numerous setae; ventral brush of segment I represented by single pair of 2- 3-branched setae (fig. 183); saddle incomplete . . . .*Wyeomyia*
   Siphon with one pair of centrally located setae; ventral brush of segment X consisting of several multiple tufts; saddle complete (fig. 173) . . . .*Orthopodomyia*

SUBFAMILY ANOPHELINAE

Knight and Stone (1977), Knight (1978) and Ward (1984) recognize three genera in the subfamily Anophelinae; *Bironella*, with four subgenera and nine species occurring in the Australian region; *Chagasia*, with four species occurring in the Neotropical region; and *Anopheles*, which is worldwide in distribution, with 342 species, subspecies and varieties in six subgenera.

Genus *Anopheles* Meigen
Subgenus *Anopheles* Meigen

Anopheles Meigen, 1818. Syst. Beschr. Zweifl. Ins. 1: 10. TYPE SPECIES: *Anopheles maculipennis* Meigen, by subsequent designation (Inter. Comm. Zool. Nomencl., 1959).

For complete synonymy see Knight and Stone, 1977: 11-12.

Of the six subgenera of *Anopheles*, only the subgenus *Anopheles* is represented in North America. Eight of the 16 North American species (north of Mexico) have been reported from New York. *Anopheles quadrimaculatus*, which is distributed throughout the State and may be locally abundant, is well known as the principal vector of human malaria in the eastern United States. This disease, once prevalent in the United States including the Northeast, had essentially disappeared by the 1930's, due partly to a decline in rural population and a subsequent interruption of the transmission cycle. This and other reasons for the disappearance of malaria in the United States have been summarized by Jamnback (1969).

Eggs of *Anopheles* species are deposited on the water surface, where they lie horizontally, often adhering to one another in configurations of ribbons, stars or triangles (Horsfall, 1955). Each egg is flattened or slightly concave dorsally, convex ventrally, and has a pair of dorsolateral, airfilled floats. Larval habitats are often species-specific and include brackish water, fresh water, stagnant pools, slowly running water, natural cavities and artificial containers. Larvae live almost entirely at the water surface, lying horizontally. Hydrophobic areas, such as those around the spiracles, palmate hairs and "notched organs" of the thorax, act as supports as they break the surface film. With few exceptions, adult female *Anopheles* feed at night or in subdued light. Virtually all species feed on warm-blooded animals. When in a resting or feeding position the proboscis, thorax and abdomen are held nearly in a straight line.

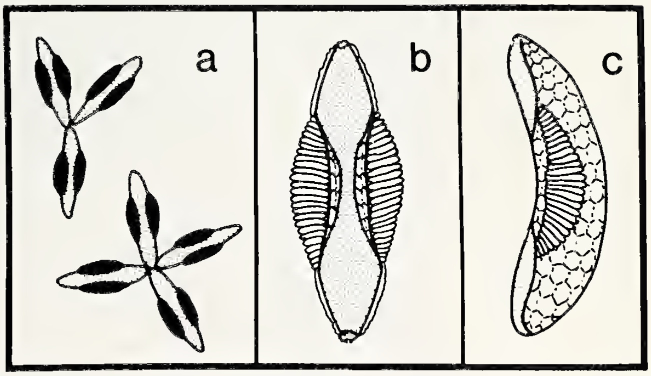


Figure 3. Eggs of *Anopheles* sp. a. eggs on water surface, b. dorsal aspect, c. lateral aspect.

DIAGNOSIS

ADULT (figs. 63-75, 201) — *HEAD*: Clypeus longer than broad; proboscis long, dark-scaled; maxillary palpus subequal to proboscis in both female and male, dark-scaled, with or without pale rings at base and/or apex of some segments; occiput clothed with erect, forked scales on median and posterior frontal regions and with a tuft of setae. *THORAX*: Mesonotum clothed with setae and scales in varying color patterns; scutellum crescent shaped, clothed with setae of various colors. *ABDOMEN*: Integument of terga usually dark, clothed with light to dark colored setae, with few or no scales; apex blunt. *LEG*: Long, slender, covered with closely appressed dark scales, sometimes with pale spots at apex of femur or tibia; without distinct tibial bristles; pulvilli absent. *WING*: Usually with distinctive patterns of light and dark scales; alula with fringe. *MALE TERMINALIA* (fig. 201): *Tergum IX* with band narrow, sclerotized in most species, lobes variable. *Tergum X* absent. *Proctiger* large, triangular or subtriangular, spiculate. *Phallosome* cylindrical, broad and forked at base, tapered to a blunt point at apex, bare or with variable leaflets at tip. *Claspette* usually with dorsal and ventral lobes having variable numbers of apical spines. *Gonocoxite* conical, about twice as long as mid width; clothed with long and short setae, sometimes also with scales on outer aspect; basal mesal and apicodorsal lobes absent; with 2 parabasal and one internal setae. *Gonostylus* about length of gonocoxite, curved, with a dorsal row of small setae; *gonostylar claw* short, blunt, peg-like, inserted at apex of gonostyle.

FOURTH INSTAR LARVA (figs. 40, 51-62) — *HEAD*: Width usually subequal to length; antenna shorter than head, usually with 2 heavy terminal spines (setae 2 and 3) and fine branched hair (seta 4); seta I-A usually small, branched, inserted on lower half of shaft, or in some species, simple, inserted near middle; setae 2-C (inner clypeal hairs) usually simple, sometimes branched or barbed; setae 3-C (outer clypeal hairs) dichotomously branched in most species, occasionally small and simple; head hairs 5-7 plumose in most species, occasionally simple. *THORAX*: A pair of transparent, retractile, anterodorsal "notched organs" present (Nuttal and Shipley, 1901). Most hairs usually plumose, varying in length. *ABDOMEN*: Hair 1 palmate, rudimentary on segments I and II, well developed and subequal in size on segments III-VII, with distal half of leaflets serrated; lateral hair (6) long, plumose on segments I-III; other hairs absent, plumose, simple or variously branched. Each segment with 1 or 2 dorsal sclerotized plates medially. Eighth segment with a posterodorsal spiracular plate and lateral pecten bearing both long and short teeth, siphon absent. *SEGMENT X*: Saddle usually covering distal half of segment; seta 1-X usually single, longer than saddle; dorsal brush consisting of two bilateral, irregularly branched hairs; ventral brush consisting of a group of irregularly branched hairs; anal papillae usually bluntly pointed, about length of segment.

KEYS TO SPECIES OF THE GENUS *ANOPHELES*

FOURTH INSTAR LARVAE

1. Lateral hair 6 plumose on abdominal segments I-VI; head hairs 5-7 small, single (fig. 56); tree hole breeder . . . . *.barberi*
   Lateral hair 6 plumose on abdominal segments I-III; head hairs 5-7 large, plumose 2
2. Setae 0 and 2 on abdominal segments IV and V both large, multiple (fig. 60) . . . . *.crucians*
   Seta 0 simple or with 2-3 branches, much smaller than seta 2 on segments IV and V 3
3. Antenna dark colored; palmate hairs (seta 1) on abdominal segments IV-VI larger than those on segments III and VII (fig. 60) . . . . *.bradleyi*
   Antenna pale colored; palmate hairs on segments III-VII all well developed, subequal 4
4. Inner clypeal hairs separated by at least width of a basal tubercle (fig. 40) . . . . *.quadrimaculatus*
   Inner clypeal hairs separated by less than width of a basal tubercle 5
5. Inner clypeal hairs (setae 2-C) with minute feathering on apical half (fig. 55); hair 2 on abdominal segment IV single . . . . *.walkeri*
   Inner clypeal hairs without feathering; hair 2 on segment IV usually with 2 or more branches . . .6

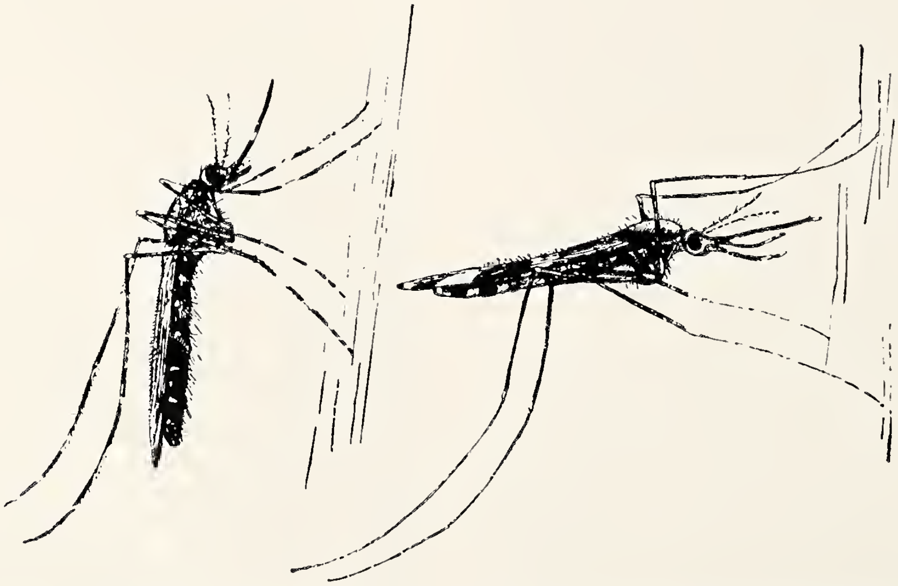


Figure 4. Resting positions of *Culex* on left, *Anopheles* on right (after Howard, 1901)

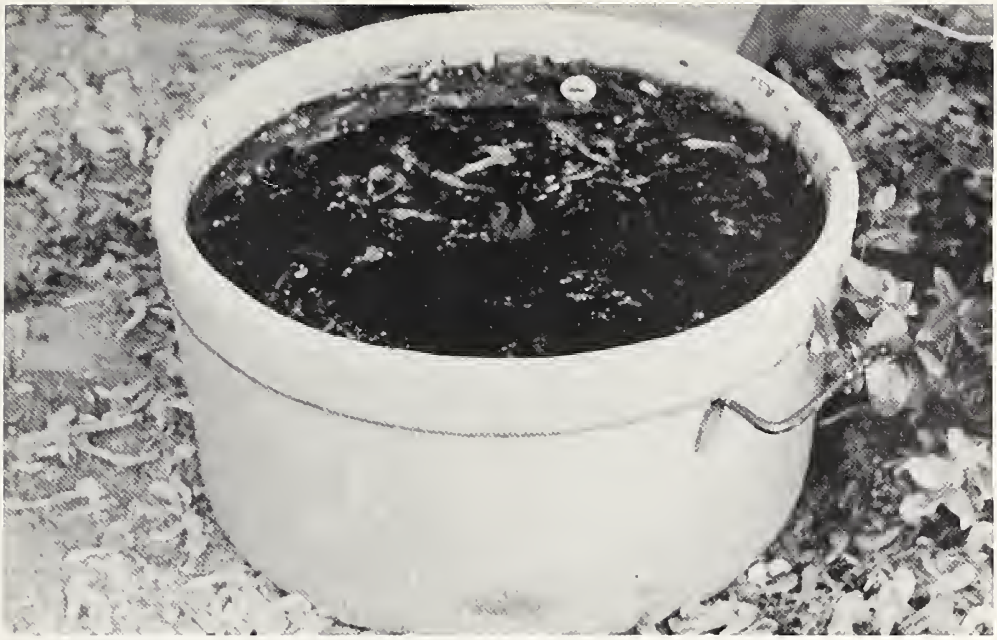


Figure 5. *Anopheles* often breed in buckets, barrels and other containers.

6. At least one inner clypeal hair (seta 2-C) branched (fig. 58) hair 2 on abdominal segments IV and V usually with more than 3 branches (fig. 61) .... *earlei*
   Inner clypeal hairs single; hair 2 on segments IV and V usually with 3 or fewer branches 7
7. Hair 2 on abdominal segments IV and V usually single; normally breeds in limestone springs; (not always separable from *An. punctipennis*) .... *perplexens*
   Hair 2 on segments IV and V usually double, sometimes triple (fig. 62); normally breeds in other than limestone springs; (not always separable from *An. perplexens*) .... *punctipennis*

FEMALES AND MALES

1. Wing with areas of pale scales (fig. 68) 2
   Wings entirely dark-scaled 5
2. One pale area on front margin of wing near tip (fig. 65) 3
   Two pale areas on front margin of wing (fig. 68) . 4
3. Cubitus-anterior (vein 5) usually pale-scaled (fig. 66); claspette of male terminalia usually with 3 setae on each side .... *bradleyi*
   Cubitus-anterior usually dark-scaled (fig. 65); claspette usually with 4 setae on each side .... *crucians*
4. Ratio of length of subcostal spot to wing length greater than 0.08 (fig. 68) .... *punctipennis*
   Ratio of length of subcostal spot to wing length less than 0.08 (fig. 67) .... *perplexens*
5. Wing clear, unspotted, less than 3.5 mm long (fig. 70) .... *barberi*
   Wing spotted by clumping of dark scales, usually more than 3.7 mm long 6
6. Maxillary palpus with narrow white bands (fig. 75a); halter knob golden yellow (sometimes darker on northern specimens) (fig. 74a) .... *walkeri*
   Maxillary palpus unbanded; halter knob dark (fig. 74b, 75b) 7
7. Costa and fringe coppery-colored at wing tip (fig. 69) .... *earlei*
   Costa and fringe uniformly colored, not spotted at wing tip (fig. 71) .... *quadrimaculatus*

Anopheles (*Anopheles*) *barberi* Coquillett

Anopheles barberi Coquillett, 1903b. Can. Entomol. 35:310. Type-loc.: Plummer's Island, Maryland, United States.

DIAGNOSIS

FEMALE — SIZE: Small. *HEAD*: Proboscis and maxillary palpus subequal, dark-scaled; occiput with many erect, dingy yellow scales; frontal tuft of bristles dark. *THORAX*: Integument light to dark brown, shiny, without median longitudinal stripe; pleura lighter than mesonotum; mesonotal setae long and dark; scutellum with many dark setae. *ABDOMEN*: Integument light to dark brown, clothed with dark brown setae. *LEG*: Uniformly dark-scaled. *WING*: Length 3.2-3.5 mm; uniformly dark-scaled on veins and fringe. *HALTER*: Knob dark-scaled.

MALE TERMINALIA — Lobes of tergum IX small, rounded, with sclerotized posterior projection. *Phallosome* broad at base, tapered to a bluntly rounded point, without apical leaflets. *Claspette* consisting of a dorsal lobe bearing 3 overlapping spatulate filaments and a ventral lobe bearing 2 broad, pointed spines, one long, the other shorter; and one slender, pointed spine.

FOURTH INSTAR LARVA — HEAD: Antenna short, smooth, dark; seta 1-A short, simple, inserted near middle of antenna shaft; terminal antennal setae long, simple; setae 2-C simple, widely spaced; setae 3-C shorter than 2-C, single or double; head hairs 5-7 short, subequal, simple. *THORAX*: Integument spiculate; prothoracic hair 1 long, sparsely feathered; hair 2 subequal to hair 1, with many branches; hair 3 short, simple; *ABDOMEN*: Hair 2 long, branched near apex on IV and V; hair 6 long, sparsely feathered on I-VI.

BIONOMICS

Immature stages of this species are normally found only in tree holes and artificial containers which are either made of wood, e.g., wooden barrels or buckets, or contain leaves and twigs (Matheson, 1944; Thibault, 1910; Zavortink, 1970). Zavortink also reported that *An. barberi* is usually recovered from sites which contain water more or less continuously. Larvae often dive when disturbed, secreting themselves in bottom debris, but soon rise to the surface, where they are easily detected because of their shiny black appearance.

In the north, this species overwinters as first or second instar larvae, often frozen in blocks of ice (Matheson, 1944; Snow, 1949). Larval development is quite rapid in spring, beginning before the frost-free season starts. Larvae mature, pupate and emerge as adults within a month, as early as April 4 in St. Louis, Missouri (Baker, 1935; Snow, 1949). There are apparently two generations in New York, with a second emergence in July, while breeding farther south is continuous throughout the year (Horsfall, 1955).

The species usually associated with *An. barberi* larvae are *Aedes triseriatus* and *Orthopodomyia signifera*, but other species, including *Toxorhynchites rutilus* and *Culex salinarius* have also been reported (Horsfall, 1955). Be-

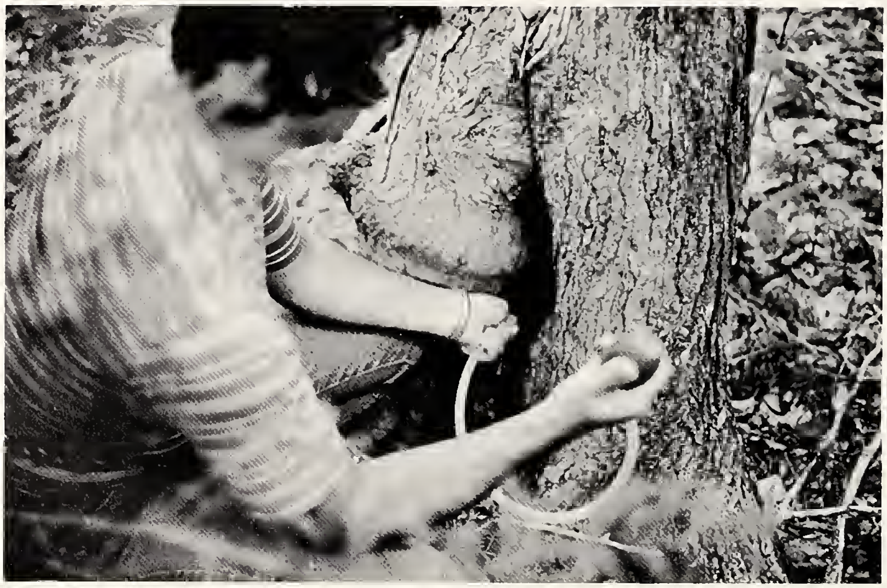


Figure 6. ***Aedes triseriatus*, *Ae. hendersoni* and *Anopheles barberi* commonly breed in treeholes.**

cause *An. barberi* larvae are predacious on other mosquito larvae (Dyar & Knab, 1906c), usually fewer than a dozen larvae are found in a site (Jenkins and Carpenter, 1946; Zavortink, 1970). The author has collected this species only rarely, fewer than six specimens each time and with no other species present.

Adults are normally found only in the vicinity of their larval sites, where they are occasionally seen resting in buildings, culverts and under bridges (Zavortink, 1970). Females attack man persistently, both in houses and outdoors. However, they are nervous feeders and seldom finish a blood meal (Thibault, 1910). Hosts other than man are unknown.

DISTRIBUTION

Anopheles barberi occurs throughout the forested regions of the eastern United States, west to Texas and north to South Dakota and New York. In New York State it has been reported from Ithaca in Tompkins County (Matheson, 1944), from Cambridge in Washington County (New York State Museum collections), Orange and Rockland Counties (Barnes et al., 1950), throughout Nassau County (W. G. McClure, pers. comm.), and near Great South Bay in Suffolk County (Guirgis and Sanzone, 1978). However, since this species is not readily detected using normal collection methods, it may occur in other areas of the State where there are suitable breeding sites.

IMPORTANCE

Stratman-Thomas and Baker (1936) demonstrated that *Anopheles barberi* could be infected with *Plasmodium vivax* and could transmit the malaria from one human to another. However, because *An. barberi* is rarely abundant and seldom comes in contact with man, it is not probable this species would serve as a vector in nature.

Anopheles (Anopheles) bradleyi King

Anopheles crucians var. *bradleyi* King; 1939. Am. J. Trop. Med. 19:468. Type-loc.: St. John's River, Brevard Co., Florida, United States.

IMPORTANT REFERENCES: King and Bradley, 1941a (to specific status); Floore et al., 1976 (revised description, illustrations).

DIAGNOSIS

FEMALE — SIZE: Moderate. Identical or nearly identical to *An. crucians* but often with vein 5 entirely white-scaled.

MALE TERMINALIA — Lobes of Tergum IX very long, slender. *Phallosome* with 3-4 pairs of acute leaflets at apex, increasing in length from proximal to distal pair. *Claspette* with dorsal and ventral lobes fused to form a single lobe having 3-5 flattened setae (usually 3, either evenly separated or with a pair of dorsal or lateral setae and a distal ventral seta, the latter more stout than the others). *Gonocoxite* usually with scales, with two parabasal spines and one internal spine.

FOURTH INSTAR LARVA — HEAD: Antenna brown, with stout, dark spicules; seta 1-A with several branches inserted near basal third of antenna shaft; seta 2-C simple, basal tubercles usually separated by diameter of one tubercle or less; hairs 5-7 large, plumose. *ABDOMEN*: Hair 0 very small, 1-3 branched on segments IV and V; hair 2 usually simple on IV and V (occasionally double or triple); hair 5 with 4 or 5 branches on I, about twice the size of hair 4.

BIONOMICS

Because this species is often indistinguishable from, and confused with, *An. crucians*, little is known about its life cycle. It probably is similar to the latter except that *An. bradleyi* usually breeds in brackish or stagnant water while *An. crucians* prefers fresh, clearer water (Kreutzer and Kitzmiller, 1971b).

Probably both *An. bradleyi* and *An. crucians* overwinter in New York as mated females, as do most other anophelines. However, the collection of fourth stage *An. bradleyi* larvae on Long Island as late as October (Barnes et al., 1950) indicates that this species may overwinter in the larval stage, as reported for *An. crucians* in the south (Frohne and Hart, 1949).

The larvae of *Anopheles bradleyi* normally occur in brackish water pools near the coast (Bradley and King, 1941; King et al., 1944; Russell et al., 1943; USPHS and TVA, 1947), especially in pools containing aquatic grasses. Griffitts (1921) found this species to be rather specific as to which grasses the larvae were associated with. He collected *An. bradleyi* larvae from a marsh in stands of *Distichlis spicata* but not from nearby stands of *Spartina alternaflora* (reported as *S. glabra*). Larvae of *An. bradleyi* have been found associated most often with *An. punctipennis*, *Culex salinarius*, *Cx. territans* (reported as *Cx. apicalis* by Dorsey, 1944), *Cx. restuans*, *Uranotaenia sapphirina*, *Aedes sollicitans* and *Ae. taeniorhynchus*. Other less common associates have included *Anopheles quadrimaculatus*, *An. crucians*, *Aedes vexans*, *Ae. canadensis*, *Ae. triseriatus*, *Culex erraticus*, *Cx. pipiens* and *Psorophora confinnis* (Barnes et al., 1950; Bradley and King, 1941; Dorsey, 1944; Griffitts, 1921; and King et al., 1944).

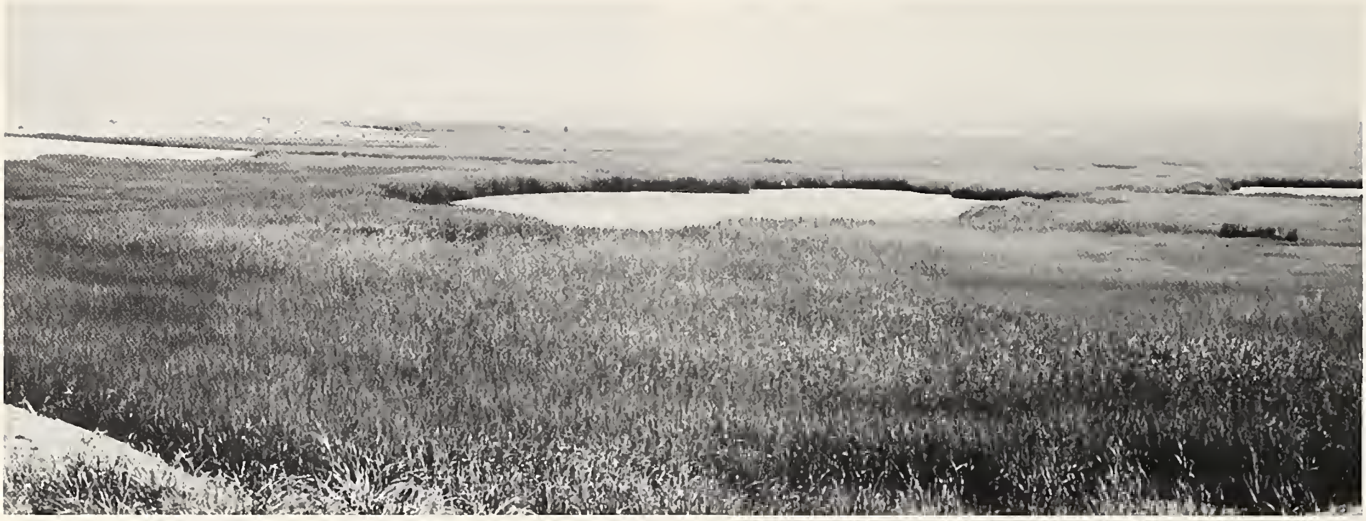


Figure 7. Long Island salt marsh — breeding area for *Anopheles bradleyi* and *Aedes sollicitans*.

King et al. (1939), who referred to the "coastal variety of *An. crucians*," reported that the species bit man outdoors at night and during the day in woods, and would enter houses, although the proportion of "*crucians*" attempting to bite in comparison to those known to be present was relatively small. It is not known what proportion of those biting man were *An. bradleyi*. These workers also reported that the coastal variety (presumably *An. bradleyi*) migrated for several kilometers when populations were unusually high. MacCreary and Stearns (1937) reported flights of at least 8.85 kilometers across Delaware Bay, and Barber and Hayne (1924) reported flights to the coast of Mississippi from offshore islands as far as 19 kilometers away.

DISTRIBUTION

Anopheles bradleyi occurs in the Atlantic and Gulf states from New York to Texas and along the gulf coast of Mexico; south into Honduras and Nicaragua. In New York it has been recorded only from coastal marshes near Jamaica, Queens County, and Bellport, Suffolk County (Barnes et al., 1950; Dyar, 1902), but because this species cannot be easily distinguished from *An. crucians*, distribution and abundance may be more extensive than is indicated by the records. This species has been reported as common in Delaware (Darsie et al., 1951; R. W. Lake, pers. comm.).

IMPORTANCE

Anopheles bradleyi, or the "coastal variety of *An. crucians*," has been infected experimentally with *Plasmodium falciparum* (Boyd et al., 1936) but has not been found naturally infected. Several isolations of various strains of California encephalitis have been made from wild populations of *An. crucians* (Sudia et al., 1971). Since the two species cannot be readily separated, some of the isolations may have been from *An. bradleyi*. One study has implicated *An. bradleyi* as a possible vector of Cache Valley virus (California group) (Buescher et al., 1970). Therefore, although the species appears to be uncommon or rare in New York, it should be considered of potential importance in the transmission of California encephalitis in coastal areas.

Anopheles (*Anopheles*) *crucians* Wiedemann

Anopheles crucians Wiedemann, 1828. Aussereurop. Zweifl. Ins. 1:12. Type-loc.: New Orleans, Louisiana, United States.

IMPORTANT REFERENCE: Floore et al., 1976 (revised description, illustrations).

DIAGNOSIS

FEMALE — *SIZE*: Moderate. *HEAD*: Proboscis black; maxillary palpus somewhat shorter than proboscis, black with a few white scales on segment 3, segment 4 ringed at both ends with white scales, segment 5 entirely white-scaled; occiput with white, erect scales in center, dark, erect scales laterally. *THORAX*: Mesonotum with a pair of narrow, submedian longitudinal black stripes, clothed with yellowish setae. *ABDOMEN*: Integument dark brown to black, clothed with yellowish to dark brown setae. *LEG*: Dark; femur and tibia each with white scales at tip.

WING: Length 4.0-4.5 mm; veins dark-scaled or with spots of white to pale yellow scales; costa dark except for pale spot at tip; stem of vein 5 mostly or entirely dark-scaled; vein 6 with 3 areas of dark scales. *HALTER*: Knob dark-scaled.

MALE TERMINALIA — Lobes of tergum IX very long, slender. *Phallosome* with 3-4 pairs of acute leaflets at apex, increasing in length from proximal to distal pair. *Claspette* with dorsal and ventral lobes fused to form a single lobe having 3-5 flattened setae (usually 4 in pairs, a dorsal or lateral pair subequal in size and shape and a ventral pair with the mosthdistal seta longer and stouter than the other. *Gonocoxite* with scales and setae, with two parabasal spines and one internal spine.

FOURTH INSTAR LARVA — HEAD: Antenna mostly light-colored, dark at apex, spiculate; seta 1-A with several branches, inserted at basal third of antenna shaft; setae 2-C simple, basal tubercles plumose. *ABDOMEN*: Setae 0 and 2 well developed, with several branches (4-13) on segments IV and V. Seta 5 on segment I with 4-5 branches, about twice the size of seta 4.

BIONOMICS

Throughout most of its range breeding of *An. crucians* is either continuous, or where temperatures drop somewhat in winter months, such as north of Louisiana, this species overwinters in the larval stage (Frohne and Hart, 1949; Griffitts, 1918; Mitchell, 1907; Peterson and Smith, 1945). The method of overwintering in New York, where winters are more severe, is not known.

Larvae are most common and abundant in semipermanent and permanent bogs, ponds, sloughs and bayous containing acidic water (Frohne, 1939, 1942; Metz, 1918; Schmitt, 1943). In southern New York State, larvae have been collected from sphagnum bogs, ponds containing large amounts of emergent vegetation and from deciduous swamps with a pH of 3.0-4.0. Although it has been reported as a fairly common species in southeastern New York (Barnes et al., 1950), larvae have been collected only rarely and it is difficult to say whether there is more than one generation during the summer.

Adults seldom enter houses (Mayne, 1926; Thibault, 1910) but are most often collected from under houses, in stables, barns, culverts, under bridges or similar shelters (Carpenter and LaCasse, 1955; Metz, 1918). Although females sometimes attack on cloudy days, and occasionally in bright sunlight (Mayne, 1926a), feeding is most often at dusk or after dark. This species feeds on man, as well as several domestic animals including cows, horses, pigs, sheep, dogs, cats and fowl (Horsfall, 1955). The author has collected *An. crucians* biting both man and chickens, in the same location, with no apparent preference for either host.

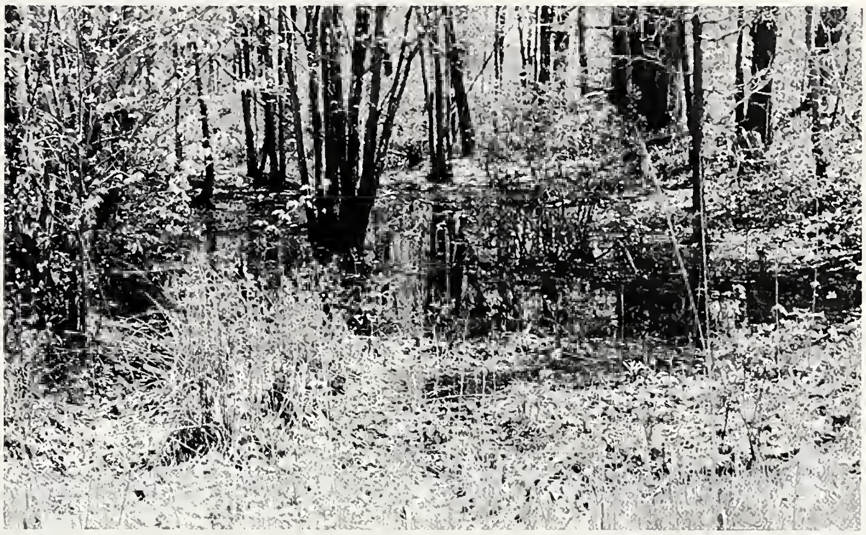


Figure 8. A sphagnum bog habitat where larvae of *Anopheles crucians*, *Culiseta melanura*, *Cs. morsitans* and other cool-water species are commonly found.

DISTRIBUTION

Anopheles crucians is common in most of the southeastern United States west to Kansas and New Mexico. Its range extends north to New York, where it has been reported only from the southern counties, from Suffolk County to West Point (Orange County), and from East Berne in Albany County (NYSM Collections). It has been reported as fairly common in parts of New York City and West Point, but is rare elsewhere. Since it has been collected to the north as far as Albany County, it may also occur elsewhere in the State.

IMPORTANCE

Although *An. crucians* can be considered a potentially important vector of malaria in the south where it is abundant (Sabrosky et al., 1946), it is unimportant in this regard in New York State as malaria is only occasionally brought into the State. Because *An. crucians* is uncommon in most of the State, it is not likely that conditions would be right for this species to act as a vector. Several arboviruses, including eastern (EEE), St. Louis (SLE), Tensaw (Bunyamwera group), Venezuelan (VEE) and various strains of California group viruses have been isolated from *An. crucians* since 1953 (Buescher et al., 1970; Chamberlain et al., 1954, 1964, 1969; Coleman, 1969; Dow et al., 1964; Karstad et al., 1957; Kissling et al., 1956; Stamm et al., 1962; Sudia and Newhouse, 1971; Sudia et al., 1968, 1969, 1971; Taylor et al., 1971; Wellings et al., 1972). Because of these several isolations of virus from New Jersey to Florida, this species is considered to be of potential importance in New York State as a possible vector.

Anopheles (*Anopheles*) *earlei* Vargas

Anopheles earlei Vargas, 1943. Bol. Cfic. Sanit. Pan-Amer. 22:9. Type-loc.: Jefferson County, Wisconsin, United States.

Anopheles maculipennis (of authors, not Meigen, for Canada and northern United States).

Anopheles maculipennis occidentalis (of authors, for Canada and northern United States).

IMPORTANT REFERENCES: Pratt, 1952; Rozeboom, 1952 (taxonomic status).

Much of the literature pertaining to *Anopheles earlei* is included in discussions of *An. occidentalis* and *An. maculipennis*, with which this species has been confused until recently. Both *An. earlei* and *An. occidentalis* are considered members of the *An. maculipennis* complex but *An. maculipennis* (strict sense) occurs only in the Palaearctic region (Continental Europe, Northern Asia), and *An. occidentalis* occurs only in a narrow strip on the western coast of North America. The relationship between *An. earlei* and *An. occidentalis* is not completely understood, but all recent mosquito taxonomists treat them as distinct species (Knight and Stone, 1977; Pratt, 1952; Rozeboom, 1952).

DIAGNOSIS

FEMALE — SIZE: Moderate. *HEAD*: Proboscis and maxillary palpus dark brown; occiput with whitish scales dorsally, brown laterally; frontal tuft with brown and whitish or silvery setae. *THORAX*: Mesonotum with short, pale yellow setae covering a broad, median frosted stripe; longer dark setae laterally; scutellum with short, yellowish and larger, brown setae. *ABDOMEN*: Terga dark brown, clothed with pale yellow to brown setae. *LEG*: Dark, with a bluish tint; femur and tibia each with white scales at apex. *WING*: Length 4.0-4.5 mm; scales dark, some forming distinctly darker spots; scales raised on stem of vein 2, between fork and dark spot; fringe at apex lighter, forming a yellowish or silvery spot. *HALTER*: Knob dark-scaled.

MALE TERMINALIA: — *Lobes of Tergum IX* about 2.0 times longer than broad, truncate at tips. *Phallosome* with 3 or 4 pairs of leaflets, increasing in length from basal to apical pair. *Claspette* with a dorsal lobe bearing 2 or 3 spines and a ventral lobe bearing 2 long spines and one short spine; dorsal and ventral lobes not always distinct.

FOURTH INSTAR LARVA: — *HEAD*: Antenna light colored basally, darker apically; seta 1-A with several branches, inserted before middle of antenna shaft; setae 2-C with two to five branches apically (occasionally simple), with basal tubercles usually separated by width of one tubercle or less; hairs 5-7 large, plumose. *ABDOMEN*: Hair 0 obsolete or minute on segments IV and V; hair 2 usually with 2 to 6 branches on IV and V.

BIONOMICS

Adult females of *Anopheles earlei* hibernate in protected places such as caves (Owen, 1937), sheds (McLeod and McLintock, 1947) and burrows of larger animals (Shemanchuk, 1965). The author has also collected overwintering females from beneath houses and porches, partially covered wells and large culverts. McLeod and McLintock (1947) observed that hibernating females could survive temperatures of –23° F in Manitoba with no ill effects. Barr (1958) reported that emergence from hibernation in Minnesota is from late April to early June. The author has collected females biting in sunlight and in shade on warm days in April in the Albany, New York area. Likewise, Matheson and Belkin (1943) observed that overwintered females attacked man readily, even in bright sunlight, and Mullen (1970) reported a female biting in sunlight in Tompkins County on April 25. Females are often collected biting and in light traps in northern New York from early May through June.

Matheson and Belkin (1943) collected mature larvae, pupae and freshly emerged adults in Schuyler County as early as May 25. Mullen (1970) collected pupae in

Tompkins County on May 26, indicating that eggs are deposited soon after emergence from hibernation. These writers also reported that no additional immature stages were collected from these areas until September and August, respectively, indicating there were apparently two generations. This author has collected third and fourth stage larvae and pupae only during July and August in northern New York.

Larvae occur primarily in cool, clear water in the shallow margins of slow-moving streams and ponds containing emergent and floating vegetation. Mullen (1970) collected larvae from a floating bed of *Ceratophyllum* (coon's tail) and *Anacharis* (*Elodea*) plants along the margin of a pond. This author has collected larvae from behind blockages in slow moving streams. Other species with which larvae of *An. earlei* have been found associated include *An. punctipennis*, *An. quadrimaculatus*, *An. walkeri*, *Culex territans*, *Cx. restuans*, *Cx. tarsalis*, *Uranotaenia sapphirina* and *Coquillettidia perturbans* (Carpenter and LaCasse, 1955; Horsfall, 1955; Mullen, 1970).

It is well known that *An. earlei* females attack and feed on man readily and ferociously, entering houses even by way of chimneys (Owen, 1937), but there are few records of feeding on other hosts. Wright and DeFoliart (1970) found that although this species was abundant in areas where they were conducting mosquito host preference tests, it was attracted to and fed only on whitetail deer, beaver, red fox and cottontail rabbit, and was apparently not attracted to other small mammals, birds or amphibians. Their limited data indicated that deer might be common hosts. The author has collected this species feeding on a dog and has observed that it appears to be as readily attracted to a dog as to man. Barr (1958) reported collections of females from pigpens and from chicken coops in Minnesota.

DISTRIBUTION

Anopheles earlei is a northern species, occurring in much of northern United States and Canada from Maine to Alaska. Because it has been confused taxonomically until recently (Pratt, 1952; Rozeboom, 1952) many of the earlier distribution records for *An. occidentalis* and *An. maculipennis* refer to *An. earlei*. The southern extent of its range is apparently central New York State. Carpenter and LaCasse (1955) mistakenly reported that Matheson (1944) recorded this species farther south, from Connecticut.

In New York State the species has been collected in small numbers from scattered localities in northern and western areas of the State as far south as Ulster county (Bast, 1970). It has been found in abundance locally in Schuyler County (Matheson and Belkin, 1943) and by the author in St. Lawrence County (Means and Watthews, 1966).

IMPORTANCE

There is no epidemiological evidence that this species is involved in transmission of malaria or encephalitis. However, Yen (1938) found that *An. earlei* may be of importance as a vector of dog heartworm (*Dirofilaria immitis*). Because *An. earlei* feeds readily on large mammals, it should be considered a possible vector in cases of epizootics of heartworm within its range. In most areas of the State this species is not common and is not considered an important pest. However, where it is locally abundant, it may be a major pest species, especially considering its attraction to man, its persistence and the ferocity of its attack.

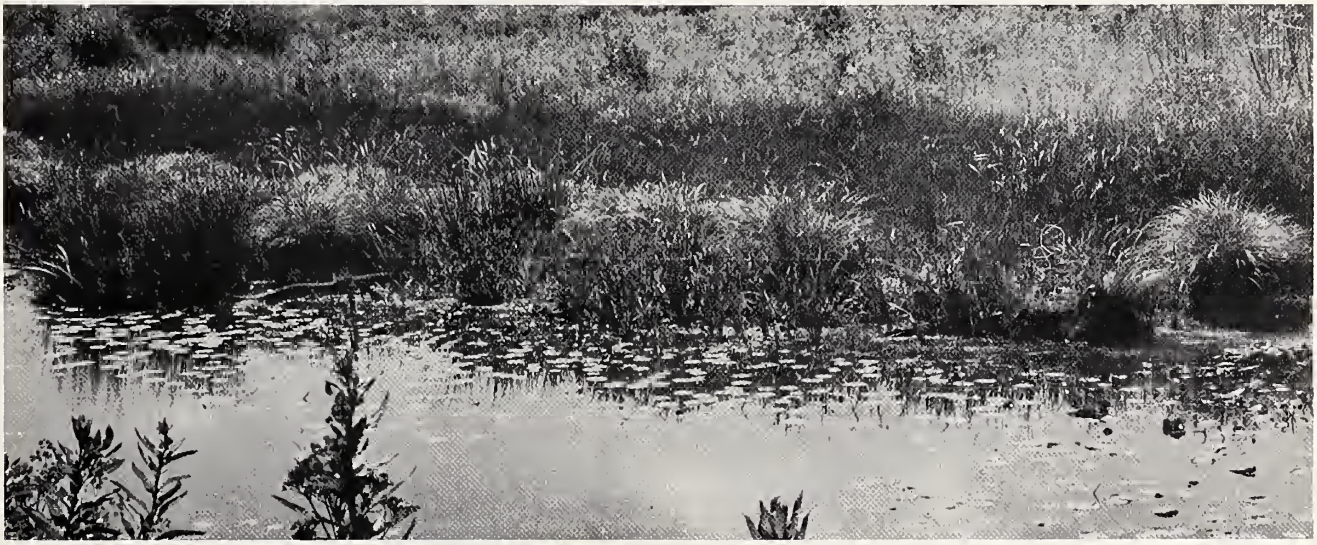


Figure 9. An open, sunlit pond with floating vegetation — typical habitat for larvae of *Anopheles earlei* and other species.

Anopheles (*Anopheles*) *perplexens* Ludlow

Anopheles perplexens Ludlow, 1907. Can. Entomol. 39:267. Typeloc.: Camp Roosevelt, Mt. Gretna, Pennsylvania, United States.

IMPORTANT REFERENCE: Bellamy, 1956:515 (resurrected from synonymy with *An. punctipennis*).

The taxonomic status of *Anopheles perplexens* has been confused since it was first described. Dyar and Knab (1908b, 1909) refused to accept Ludlow's species as being of American origin and later placed it in strict synonymy with *An. punctipennis* (Howard et al., 1917). The reader is referred to Bellamy (1956) for an explanation of the complete synonymy of these two species.

According to Ludlow's original description, which was confirmed by Bellamy, *An. perplexens* adults are generally smaller and darker than *An. punctipennis* and often show a considerable reduction in the size of the light spot on the costa. In addition, the larvae of *An. perplexens* are only known to occur in limestone springs, the streams that they form, and lime sink holes, while larvae of *An. punctipennis* commonly occur in a variety of temporary and permanent waters, including floodplain pools not associated with limestone springs.

Based on several thousand rearings of both *An. perplexens* and *An. punctipennis* type females, Bellamy found that the ova are distinct and that they can be separated by the ratio of the width of exposed endochorion between floats to egg length (average 0.104 for *An. punctipennis*, 0.049 for *An. perplexens*). Bellamy also found that, although there were marked statistical differences in certain characters of both fourth instar larvae and adults, individual larvae, pupae or adults, including male terminalia, could not be distinguished with certainty.

Because it is difficult, if not impossible, to distinguish *An. perplexens* from *An. punctipennis* based on morphological characters it can be assumed that some of the studies on life history, behavior, seasonal occurrence, geographic distribution and medical importance may have included both species. Until further studies have been done on these as distinct species, it can also be assumed that much of this information included in the discussion of *An. punctipennis*, except for breeding areas, may also apply to *An. perplexens*.

Knight and Stone (1977) have listed the distribution of *An. perplexens* as eastern United States. This species is apparently abundant in the Southeast, where specimens were obtained by Bellamy for study. Since it was first described from Mt. Gretna, Lebanon County, in southeastern Pennsylvania, which is not far from the New York border, it may well occur in New York State where limestone springs are found.

Anopheles (*Anopheles*) *punctipennis* (Say)

Cules punctipennis Say, 1823. J. Acad. Nat. Sci. Phila. 3:9. Type-loc.: Chestertown, Kent County, Maryland, United States.

Culex hyamalis Fitch, 1847. Am. J. Agric. Sci. 5:281. Type-loc.: Washington County, New York, United States.

Anopheles punctipennis var. *stonei* Vargas, 1941. Rev. Soc. Mex. Hist. Nat. 2:179. Type-loc.: Monterrey, Nuevo Leon, Mexico.

IMPORTANT REFERENCES: Belkin et al., 1966:2 (restriction of type-loc.); Bellamy, 1956 (resurrection of *An. perplexens* from synonymy with *An. punctipennis*); Kreutzer, 1977:265 (relationship of *An. punctipennis* to *An. maculipennis* group).

DIAGNOSIS

FEMALE — *SIZE*: Moderate. *HEAD*: Proboscis and maxillary palpus entirely dark-scaled; occiput with forked scales on central part white, others dark; frontal tuft white. *THORAX*: Mesonotum with a broad, median, frosted stripe clothed with pale yellow setae; lateral areas dark brown with larger dark setae; scutellum clothed with yellow hairs and brown setae. *ABDOMEN*: Integument dark brown to black, clothed mostly with dark hairs. *LEG*: Femur and tibia with pale scales at apices. *WING*: Length 4.0-4.5 mm; scales black and light yellow; costa with pale spot at end of subcosta; veins 3 and 5 dark-scaled; vein 6 dark-scaled at base and apex, pale-scaled on central third. *HALTER*: Knob dark scaled.

MALE TERMINALIA — *Lobes of tergum IX* finger-like, about 3.0 times longer than wide, somewhat constricted medially. *Phallosome* with 3 or 4 pairs of leaflets, increasing in length from basal to apical pair. *Claspette* with *dorsal lobe* bearing one or 2 long, stout, pointed spines and a *ventral lobe* bearing a long, stout, pointed spine, a long slender spine and a short slender spine; lobes fused basally, distinct apically.

FOURTH INSTAR LARVA — *HEAD*: Antenna light colored basally, darker apically, spiculate; seta 1-A with several branches, inserted near basal third of antenna shaft; setae 2-C simple, with basal tubercles separated by less than diameter of one tubercle; hairs 5-7 large, plumose. *ABDOMEN*: Hair 0 obsolete on segments IV and V; hair 2 usually double (occasionally single or triple) on IV and V; hair 5 usually with 3 branches, slightly longer than hair 4 on segment I; lateral hair 6 long, plumose on I-III.

BIONOMICS

Anopheles punctipennis overwinters as inseminated females in protected places such as cellars, abandoned buildings, wells, caves and other similar habitats. The author has found, as reported by Berg and Lang (1948), that only subterranean shelters are used for overwintering in the north. Females emerge in the spring, take a blood meal, and deposit eggs singly on the water surface in loose, irregular strings of up to 20 eggs (Horsfall, 1955). Matheson (1944) reported he had been bitten by *An. punctipennis* outdoors as early as March 31 in central New York, and the author has collected biting females in the Albany area by mid-March.

Larvae are found primarily in small permanent streams, especially streams which are at least partially shaded, contain emergent vegetation and/or blockages and are slow-moving, in small ponds among emergent weeds and grasses, and in containers such as wooden tubs or barrels. The author has collected larvae from the water-holding leaf axils of the teasel (Means, 1973). They are found in turbid hog wallows as well as clear water (Bellamy, 1956; Matheson, 1944). Horsfall (1955), in summarizing the findings of others, stated that weeds are especially important to the well-being of *An. punctipennis* larvae but that the particular kinds of weeds are unimportant. The author has most often found larvae behind blockages caused by overhanging tree limbs and brush and in weeds near pond outlets, especially at the edge of wooded areas. Water depth appears to matter little provided that adequate vegetation is present. Water temperature, however, is very important, cooler water being preferred. Horsfall and Morris (1952) found larvae to be four times as common where water was 18° C than where it was 25° C in the same marsh.

Larvae of *An. punctipennis* lie, as do larvae of other anophelines, on the water surface with their bodies parallel to the surface. Unlike some other species, however, larvae of this species lie with the entire length of the body breaking the water surface rather than just the head and caudal ends. Larvae have also been observed to drop to the bottom when disturbed, where they lie still, often for several minutes.

Larvae of *An. punctipennis* are found associated with larvae of several other multivoltine species, including *An. quadrimaculatus*, *Culex restuans*, *Cx. territans*, *Cx. salinarius*, *Cx. erraticus* (in Virginia), *Aedes vexans* and *Uranotaenia sapphirina* (Horsfall, 1955). In New York State the author has most often found this species associated with *An. quadrimaculatus*, *Culex territans*, *Aedes vexans* and occasionally with *Cx. restuans*.

Larvae of *An. punctipennis* are not usually found in New York until mid-June or later. Larval development requires 12 to 15 days in the presence of abundant food and sometimes much longer under less ideal conditions. They are resistent to cold water and have been reported to complete normal development after having been frozen in ice for extended periods (Balfour, 1928; Smith, 1904). The author has observed, as reported by Griffitts (1918), that larvae may sink to the bottom of the pool when the water is cold, e.g., during the night and early morning in late summer and fall, and rise to the surface when the water warms up during the day. Under such conditions, larvae usually require 30-40 days or more for development. Matheson (1944) reported that the number of generations depends largely on the locality. He found there were only two broods a year at Lake Cayuta in central New York, at an elevation of over 1200 feet.

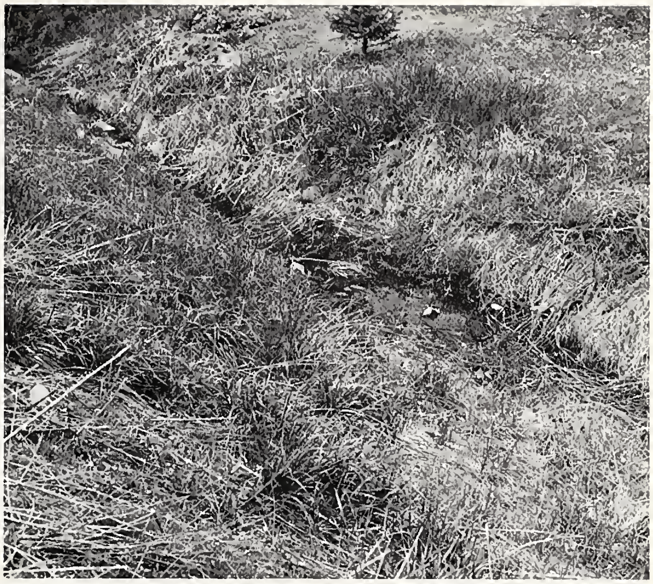


Figure 10. Slowly-moving, grassy roadside ditches often serve as breeding sites for *Anopheles punctipennis*.

Anopheles punctipennis females readily bite humans, especially outdoors in the early evening, but also in the shade on warm, sunny days. The author has found that overwintered females are especially annoying on warm spring evenings, prior to the emergence of most snowpool *Aedes* species. Horsfall (1955), Edman and Downe (1964), Reeves and Hammon (1944) and others have also reported that this species feeds naturally on several domestic animals including cow, horse, pig, sheep, dog, cat and fowl. In addition, Murphey et al. (1967) found that *An. punctipennis* engorged on the following warm-blooded animals in host preference tests: Birds: mallard, barn owl, red-winged blackbird, chicken; Mammals: woodchuck, muskrat, raccoon, opossum, red fox, meadow vole, river otter, guinea pig. These authors were of the opinion that although *An. punctipennis* could be considered a general feeder on warm-blooded animals (none was attracted to amphibians or reptiles), it showed a slight preference for mammals.

DISTRIBUTION

Anopheles punctipennis has the greatest range of any of the Nearctic anophelines (King and Bradley, 1941b). It is distributed from southern Canada, throughout the United States (except in the western mountains and plains), south into Mexico (Horsfall, 1955; Knight and Stone, 1977). It is common throughout New York State and is sometimes very abundant locally, especially following heavy summer rains in the vicinity of slow-moving streams.

IMPORTANCE

Horsfall (1955) summarized the findings of several workers on the role of *Anopheles punctipennis* as a potential vector of malaria (*Plasmodium vivax* and *P. falciparum*) to humans. He reported that *An. punctipennis* is capable of transmitting the plasmodia that infect man. Potentially it is as important a vector as *An. quadrimaculatus*, but has rarely been found infected in the wild, therefore, its importance as a vector is minimal. This may be due to the fact that although *An. punctipennis* females bite man readily outdoors, they do not normally enter houses or other human habitations, as do *An. quadrimaculatus* and other malaria vectors (USPHS and TVA, 1947).

In addition to being a potential, though unlikely, malaria vector, *An. punctipennis*, has been shown to be a very good carrier of dog heartworm (*Dirofilaria immitis*) (Hu, 1931; Kartman, 1953; Phillips, 1939; Yen, 1938). Phillips examined 560 mosquitoes representing six species which had been attracted to an infected dog in a 2-week period in June near Boston, Massachusetts, and found *An. punctipennis* to have the highest intensity of infection of all the species examined.

Figure 11. ***Anopheles quadrimaculatus* that developed in this pond were very abundant as adults in the barns in the background.**

***Anopheles (Anopheles) quadrimaculatus* Say**

Anopheles quadrimaculatus Say, 1824. *In* Keating, Narr. Exp. Source St. Peter's River 2:356. Type-loc.: Wabash, Minnesota, United States.

Anopheles annulimanus Van der Wulp, 1867. Tijdschr. Entom. 10:129. Type-loc.: Wisconsin, United States.

IMPORTANT REFERENCES: Barr, 1958 (bionomics); Boyd, 1930a (bionomics); Horsfall, 1955 (bionomics).

Because of its importance as a vector of malaria in North America, there have been many studies done on the biology of *Anopheles quadrimaculatus*. Much of this literature has been summarized by Barr (1958), Boyd (1930a, 1949) and Horsfall (1955). Because malaria, once prevalent in New York, is now nonexistent except for an occasional introduced incident, *An. quadrimaculatus* no longer holds the major importance in the State that it once did. For this reason details of these biological studies are not included here but the reader is referred to the above mentioned summaries for further information.

DIAGNOSIS

FEMALE — SIZE: Moderate. *HEAD*: Proboscis and maxillary palpus entirely dark-scaled; occiput with forked scales of median area pale; frontal tuft with dark and pale setae. *THORAX*: Mesonotum clothed with pale yellowish setae, more numerous and shorter medially; scutellum with short, pale yellow and long, dark setae. *ABDOMEN*: Integument of terga dark brown or black, clothed with short yellowish-brown setae. *LEG*: Dark-scaled, with pale scales at apices of femur and tibia. *WING*: Length 4.34.7 mm; scales entirely dark, some forming 4 distinctly darker spots; numerous scales on membrane between veins. *HALTER*: Knob dark-scaled.

MALE TERMINALIA — Lobes of tergum IX finger-like, about 2.0 times longer than wide, somewhat constricted medially. *Phallosome* with 3 or 4 pairs of leaflets increasing in length from basal to apical pair. *Claspette* with a *dorsal lobe* bearing 1-5 long, stout spines, usually rounded apically, sometimes fused to each other, and a *ventral lobe* bearing 1-3 long, pointed spines; lobes fused basally, more or less distinct apically.

FOURTH INSTAR LARVA — HEAD: Antenna light colored, spiculate; seta 1-A long, with many branches, inserted near middle of antenna shaft; setae 2-C simple, with basal tubercles separated by at least the diameter of one of the tubercles; hairs 5-7 large, plumose. *ABDOMEN*: Hair 0 obsolete on segments IV and V; hair 2 usually single (occasionally double) on IV and V; lateral hair 6 long, plumose on I-III.

BIONOMICS

Anopheles quadrimaculatus overwinters as unfed, inseminated females in protected places, such as barns, culverts, caves, hollow trees, wells, burrows and cellars. Smith (1904) reported that hibernation begins in New Jersey in September or October and Atchley et al. (1955) found that larval breeding is interrupted in South Carolina when the temperature reaches 5° C (approx. 40° F). Boyd (1930a) reported that hibernating females have large fat bodies. The author has observed such females with large fat bodies resting in a crawl space under a dwelling in the Albany area beginning in September, when the night time temperatures averaged about 40° F. Huffaker (1942) observed that this species was not well adapted to winter survival in Delaware, where less than 10% of those present in early December survived, even where temperatures were normally not below 30° F.

Females begin to leave overwintering sites in mid-spring (late March to early May in New York State), take a blood meal, and lay eggs singly on the water surface. Eggs are deposited primarily in permanent or semipermanent fresh water, especially water which is alkaline or only slightly acidic. However, Chidester (1920) and Vogt (1947) reported larvae are occasionally found in brackish water. Preferred breeding places include slow moving streams, canals, lakes, ponds and even puddles which contain considerable emergent vegetation. Eggs tend to congregate on the water surface in patterns, especially in the intersection lines, or meniscuses, around stems of aquatic plants. Apparently it is the extent of these meniscuses which determines the quantity of *An. quadrimaculatus* that are produced, more eggs being laid in mats of plants which have a greater number of meniscuses than in others. In this type of environment the adult mosquito finds an ideal site for ovipositing, and the larvae are provided with both adequate food and protection from predators and from wave action (Roseboom and Hess, 1944).

Larvae are most common and abundant in water at about 25° C with a low canopy shade to prevent overheating, where they congregate in the vegetation (Horsfall and Morris, 1952). Rozeboom (1942) also observed that intermittent shade was more desirable than dense shade. Species with which *Anopheles quadrimaculatus* larvae are most commonly associated in the northeast are *An. punctipennis* and *Culex territans*. In Virginia, Dorsey (1944) observed that *Cx. erraticus* was also a common associate of *An. quadrimaculatus*. The duration of the larval stage is dependent upon several factors, including temperature, population density, type and amount of food and water depth. Under normal conditions at 24° C the larval period is approximately 17 days (Keener, 1945), however, lower temperatures, overcrowding and deeper water tend to lengthen the duration of this stage. The pupal stage normally requires 3-4 days. Darrow (1949) and others have demonstrated that pupae are resistant to prolonged removal from water, a factor to be considered when attempting control by water level manipulation.

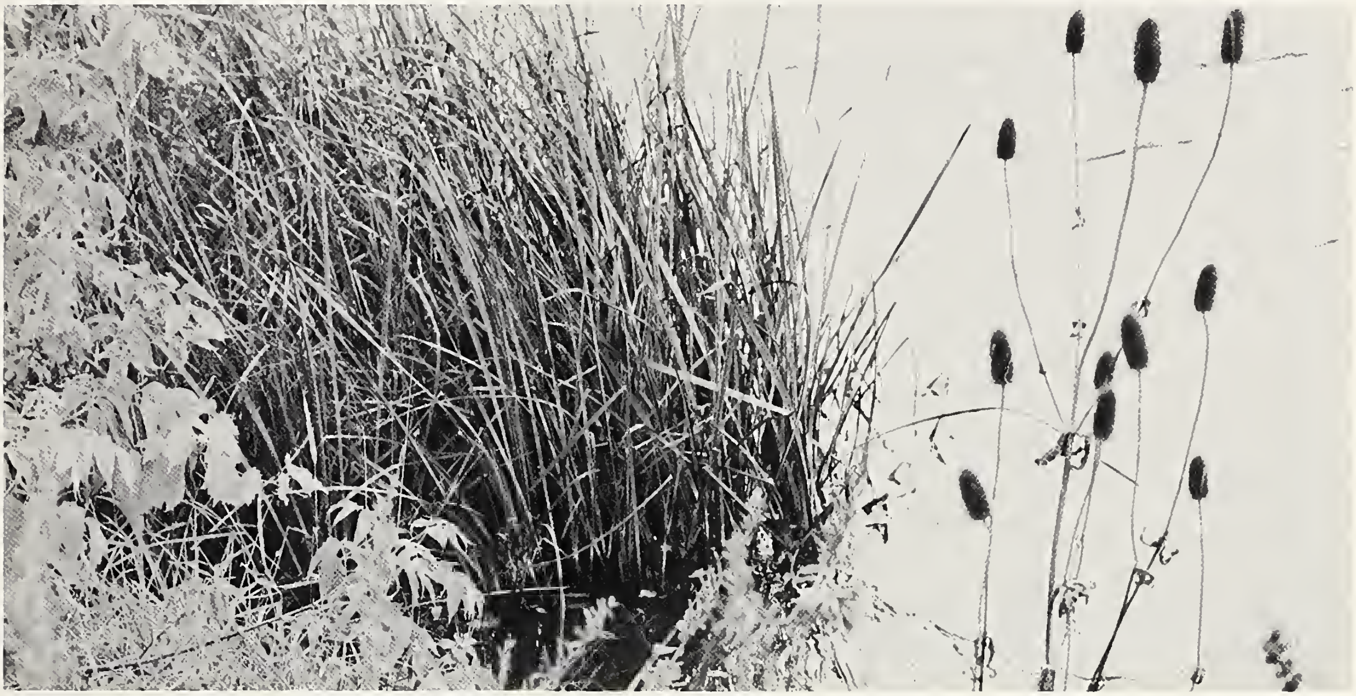


Figure 12. Emergent vegetation at the edge of a pond is a preferred habitat for *Anopheles quadrimaculatus* larvae.

Females mate soon after emergence, obtain a blood meal within 18-24 hours, and oviposit about three days later (Keener, 1945). As many as 12 oviposition efforts have been observed, with an average of 660 eggs deposited during the lifetime of caged females. Both feeding and oviposition occur at night, from dusk until dawn. Diurnal resting places are usually cool, dark places not far from where nocturnal feeding occurs, such as barns, wells, cellars, crates, boxes or kegs, with dark surfaces being most commonly used.

Mammals are apparently the preferred hosts of *Anopheles quadrimaculatus*, with humans being somewhat less attractive in general than cows and horses, and with rabbits and chickens being poor hosts, even in the absence of other sources of blood, according to Bull and Boot (1923). These authors also stated that variation between individuals is often greater than between species. Horsfall (1955) reported that this species fed naturally on man, cow, horse, pig, sheep, dog, cat and fowl in domestic situations but that hosts varied according to the collection site. Boyd (1930a, b) likewise found that nearly half of the *An. quadrimaculatus* collected from under houses had fed on man, while collections by several workers outside of dwellings included only 1-5% which had fed on humans (Horsfall, 1955). Crans (1964) found in blood meal determination studies, and Murphey et al. (1967) in host exposure tests, that mammals, especially larger mammals, were preferred over birds, amphibians or reptiles. Hosts reported by these workers other than the domestic hosts mentioned above were: Mammals: deer, rodent, woodchuck, muskrat, raccoon, opossum, red fox, meadow vole, river otter, guinea pig; Birds: mallard, Canada goose, common egret, barn owl, redwinged blackbird, turkey vulture; Reptiles: northern watersnake, snapping turtle, eastern box turtle.

DISTRIBUTION

Anopheles quadrimaculatus is generally distributed in eastern North America from southern Canada to Mexico, west to the Dakotas, Nebraska, Kansas, Oklahoma and central Texas. It has been found in all sections of New York State wherever suitable breeding areas occur, especially in rural farming areas. It has been collected in large numbers as far north as Plattsburgh (Clinton County) and Massena (St. Lawrence County) from cow barns.

IMPORTANCE

Anopheles quadrimaculatus is the principal vector of malaria in eastern United States. Benign tertian malaria (caused by *Plasmodium vivax*), a non-fatal type of malaria adapted to the temperate climate of the Northeast, has been recognized as a factor in the colonization of the coastal United States (Herms and James, 1961). Although 6-7 million cases were reported annually from the continental United States as recently as the 1930's, the last reported cases from New York occurred in 1922. The decline and disappearance of malaria, first in the Northeast, then farther south, was due, at least in part, to increased industrialization and a corresponding decrease in the rural farm population, resulting in reduction of transmission to a point where the cycle was interrupted and the disease disappeared (Jamnback, 1969).

It must be emphasized, however, that *An. quadrimaculatus* is still widespread in New York and the rest of the Northeast, and when proper conditions exist it may acquire this or other types of malaria from infected people entering the State and transmit the disease to other residents. Two such cases were reported in 1943, and another in 1966, from Nassau County (Jamnback, 1969). Another presumptive case of *An. quadrimaculatus*-transmitted *Plasmodium falciparum* from an infected counselor to another counselor at a children's camp in southwestern New York was reported in 1972 (Benach et al., 1972). In view of the previous history of the effectiveness of *An. quadrimaculatus* as a vector of malaria, this species should be considered a potential health hazard, especially whenever people enter the State from countries where malaria is prevalent (e.g., when servicemen return from tropical areas of the world).

In addition to being a potential health hazard *An. quadrimaculatus* is also an important pest species where it is locally abundant. It attacks man readily, both indoors and out, biting primarily at night. It has been described as a "greedy biter" in Arkansas (Thibault, 1910) because of its habit of repeatedly attacking the same host.

Anopheles (*Anopheles*) *walkeri* Theobald

Anopheles walkeri Theobald, 1901a. Mon. Cul. 1:199. Type-loc.: Lake Simcoe, Ontario, Canada.

DIAGNOSIS

FEMALE — *SIZE*: Moderate. *HEAD*: Proboscis and maxillary palpus dark-scaled, with white ring at apex of each segment of palpus; occiput with dark, erect scales except for a few pale scales on vertex; frontal tuft dark brown. *THORAX*: Mesonotum with short, golden-brown setae medially, longer, dark setae laterally; scutellum with golden-brown and dark brown setae. *ABDOMEN*: Terga densely clothed with yellow to light brown setae. *LEG*: Dark-scaled, with pale scales at apices of femur and tibia.

WING: Length 4.0-4.5 mm; scales dark, some scales darker, forming 4, more or less distinct, spots. *HALTER*: Knob usually pale-scaled (occasionally dark-scaled, according to Stone, 1953).

MALE TERMINALIA — Lobes of tergum IX slender, tapered, about 1.5 times longer than width at base. *Phallosome* with 3-5 pairs of leaflets at apex, increasing in length from basal to apical pair, the anteapical pair at least 0.5 times length of apical pair, none with coarse basal teeth. *Claspette* with *dorsal lobe* bearing 1 or 2 stout, blunt apical spines, and *ventral lobe* bearing a long, stout, pointed spine and a long, slender, pointed spine.

FOURTH INSTAR LARVA — HEAD: Antenna light colored, spiculate; setae 1-A multiple, inserted on lower third of antenna shaft; setae 2-C with sparse feathering toward tips; basal tubercles separated by less than diameter of one tubercle (rarely slightly more); hairs 5-7 large, plumose. *ABDOMEN*: Hair 0 on segments IV and V with 3-7 branches, shorter than hair 2; hair 2 usually single (occasionally 2- 3-branched) on segments IV and V; hair 6 long, plumose on I-III.

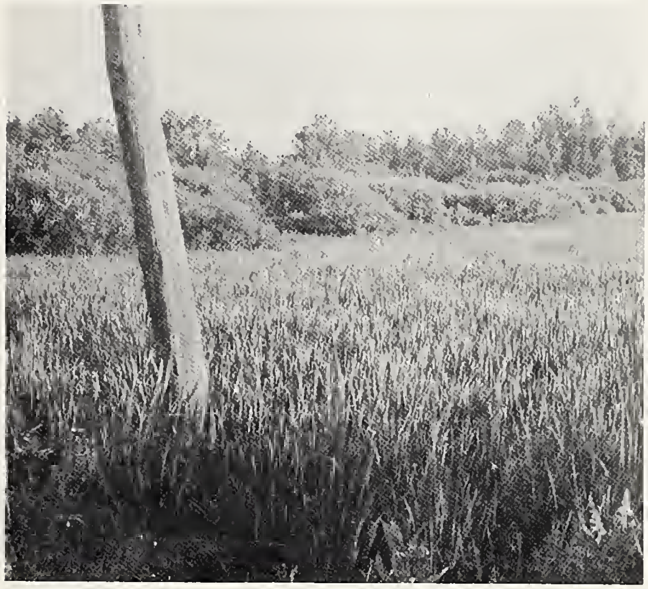


Figure 13. ***Anopheles walkeri* larvae are found in marshes such as this, where the water is partially shaded by dense grass and weeds.**

BIONOMICS

Anopheles walkeri is the only North American mosquito species known to exhibit the type of life cycle which has the combination of 1) overwintering in the egg stage, 2) eggs laid on the water surface, and 3) several generations per year (Matheson and Hurlbut, 1937; Pratt, 1959).

Hurlbut (1938) found that overwintering eggs differed from summer eggs in structure (the "winter eggs" being larger) and in physiology. Normal "summer eggs" hatched after about 3 days at 21°F, while most of the winter eggs required conditioning for several months at low temperatures before hatching. Peters (1943) found that eggs could survive temperatures as low as –21°F for 72 hours with at least 50% survival. Eggs laid for overwintering which were kept outdoors at Ithaca, New York, began hatching when the temperature was about 8°C (44°F). Breeland et al. (1961) also reported that overwintered eggs hatched in April, while the water temperature was still in the 40's (Fahrenheit), in Tennessee. In New York State, larvae have been collected as early as April in Orange County (Barnes et al., 1950), and adults have been collected in light traps in Suffolk County in May (Guirgis and Sanzone, 1978). Peters collected the first larvae from overwintered eggs in Minnesota on April 9, the first adults in light traps on May 20 and summer eggs first appeared on June 1. Mullen (1970) reported there were probably four generations of *An. walkeri* in Tompkins County, New York, as has been reported for Minnesota (Peters, 1943).

Larvae of *An. walkeri* are most commonly found in permanent or semi-permanent fresh water marshes containing emergent vegetation, such as grass-lined pools, lake edges, and cattail marshes (Matheson, 1944; Matheson and Hurlbut, 1937; Ross, 1947). Ponds with cutgrasses (*Zizaniopsis mileacea* and *Ieersiz oryzoides*), lizardtail (*Samurus cernuus*), arrowhead (*Sagittaria* sp.) or waterwillow (*Decodon vertillatus*) growing along the edges are particularly suitable for larval production (Bang et al., 1943; Peters, 1943; Snow and Smith, 1957).

Larvae normally prefer shaded situations, but Peters (1943) also found them in sunlit areas. The author has collected larvae most often in Suffolk County from partially shaded cattail marshes and from partially shaded grassy pools adjacent to sphagnum bogs, but not from within the bogs themselves. Larvae are usually dispersed over the entire breeding area rather than being concentrated in a small area (Barr, 1958). They often dive when disturbed and remain on the bottom for long periods (Breeland et al., 1961). The author has observed that larvae of *An. walkeri* often conceal themselves beneath leaves or vegetation at the bottom of a pool for as long as 5 minutes before returning to the surface, making them inconspicuous and difficult to collect. Considering these two larval characteristics, along with the secretiveness of the adult, which will be discussed later, this species may actually be more common and abundant than usually reported. *Anopheles walkeri* larvae are most commonly associated with *An. punctipennis* and *An. crucians*. In addition, Mullen (1970) found them associated in Tompkins County with *Culex territans*, *Culiseta morsitans*, *Coquillettidia perturbans*, *Uranotaenia sapphirina* and *Aedes cinereus*.

During the summer, *An. walkeri* adults commonly rest during the day on emergent aquatic vegetation close to the water rather than in kegs, culverts, barns or other shelters where other anopheline species are found. When weather is cooler in the fall, small numbers of *An. walkeri* are found resting in barns after feeding on animals in the barnyards (Snow and Smith, 1957). Because this species is not usually collected in the same places as other anophelines, *An. walkeri* is often reported as rare when, in fact, it may be quite abundant (Barr, 1958). Females are more readily collected, however, in light traps and night-biting collections such as the night "parked car technique" described by Snow and Smith (1957). Ross (1947) and Carpenter and LaCasse (1955) observed that, unlike *An. quadrimaculatus*, *An. walkeri* females bite readily during the day as well as at night, even in bright sunlight.

Anopheles walkeri females are active late into the fall and can tolerate very cool temperatures. Snow and Smith (1957) collected females biting on December 14 in Tennessee, long after there had been killing frosts. This species bites man readily and has been reported biting many domestic animals, primarily mammals. Precipitin tests on recently engorged specimens have shown blood feeding on man, cattle, horse, mule, swine, dog, sheep and fowl (Bang and Simpson, 1942; Bang et al., 1940; Snow, 1955). The author has observed, as has been reported previously (Breeland et al., 1961; Mullin, 1970) that female *An. walkeri* tend to feed near ground level, usually below the knee.

DISTRIBUTION

Anopheles walkeri is distributed throughout eastern North America, from the Gulf north to southern Canada and west to Nebraska and Texas. It has been collected from scattered localities in New York State, most often from Long Island. Collection records indicate this species is uncommon or rare in the State. However, because the adults are secretive and the larvae often difficult to detect or collect, it may be more common than the records indicate.

IMPORTANCE

Anopheles walkeri has been found able to transmit (*Plasmodium vivax* (Matheson et al., 1933) and *P. falciparum* (Kitchen and Bradley, 1936) in the laboratory, and Bang et al. (1940) found a single specimen infected with plasmodia in the wild. However, it is considered to be of little consequence in natural transmission of malaria, due, at least in part, to its non-domestic habits (Breeland et al., 1961; Horsfall, 1955). It has been reported that dog heartworm (*Dirofilaria immitis*) is able to develop to the infective stage in this species, and *An. walkeri* could act as a vector (Arnott and Edman, 1978; Todaro et al., 1977).

SUBFAMILY CULICINAE

Knight and Stone (1977), Knight (1978) and Ward (1984) recognized 10 tribes, with 33 genera containing 2753 species, subspecies and varieties in the subfamily Culicinae. Of these, 8 genera and 26 species in the tribes Aedini, Culicini, Culisetini, Mansoniini, Orthopodomyiini, Sabethini and Uranotaeniini are included here as occurring, or possibly occurring, in New York in addition to the 31 species of *Aedes* discussed in *Mosquitoes of New York, Part I.*

Tribe Aedini

The genus *Aedes*, which was discussed in detail in *Mosquitoes of New York, Part I* (Means, 1979), is the largest genus of the Culicidae, with 960 species, subspecies and varieties in 40 subgenera listed by Knight and Stone (1977), Knight (1978) and Ward (1984). The 8 remaining genera in the tribe Aedini contain 206 species, subspecies and varieties. Of these, only the genus *Psorophora* is represented in New York.

Genus *Psorophora* Robineau-Desvoidy

Psorophora Robineau-Desvoidy, 1827. Mem. Soc. Hist. Nat. Paris 3:412. TYPE SPECIES: *Culex ciliatus* Fabricius, by subsequent designation (Theobald, 1901a:263).

The genus *Psorophora* occurs throughout the tropical and temperate regions of North and South America and nearby islands. Three subgenera, *Grabhamia*, *Janthinosoma* and *Psorophora*, and 47 species were recognized by Knight and Stone (1977), Knight (1978) and Ward (1984). The genus is distributed primarily in tropical climates, but all three subgenera are represented in the northeastern United States, with six species reported from, or possibly occurring, in New York.

Northern species of *Psorophora* overwinter as eggs, which are deposited singly on moist soil in depressions subject to flooding by summer rains and overflowing rivers. Larval development is rapid and there may be several generations a year. Larvae of some species are predacious on other mosquito larvae. Adults of many species are vicious biters and some have been incriminated in the transmission of encephalitis viruses to man and domestic animals.

DIAGNOSIS

ADULT (figs. 86-108) — *HEAD*: Proboscis slender, entirely dark-scaled, or with scattered, pale scales or a band of pale scales; maxillary palpus of female about 0.3 times length of proboscis, entirely dark-scaled in most species; occiput variable. *THORAX*: Mesonotum and scutellum with varying scale patterns; scutellum trilobed, with setae on lobes; pleura with patches of broad, appressed, dingy white or grayish scales, quite extensive and dense in some species; mesonotum without setae; prespiracular and postspiracular setae present. *ABDOMEN*: Terga with varying patterns of pale and dark scales (nearly all pale-scaled, or almost entirely dark-scaled, or with both dark and pale scales intermixed); apex of abdomen tapered, with eighth segment retracted; cerci of female long, prominent. *LEG*: Pattern of dark and pale scales variable, some segments with erect scales giving a shaggy appearance in some species. *WING*: Scales varying with species, with narrow, dark scales only, or with broad, mixed dark and pale scales; alula fringed.

MALE TERMINALIA (figs. 104-108) — *Lobes of tergum IX* usually rounded, with several setae. *Tergum X* sclerotized apically, with few or no apical teeth. *Phallosome* variable in form, not completely divided, usually open ventrally, closed dorsally, at least on basal half. *Claspette* well developed, variable in form. *Gonocoxite* elongate, subcylindrical, without basal or apical lobes. *Gonostylus* elongate, well developed, variable in form.

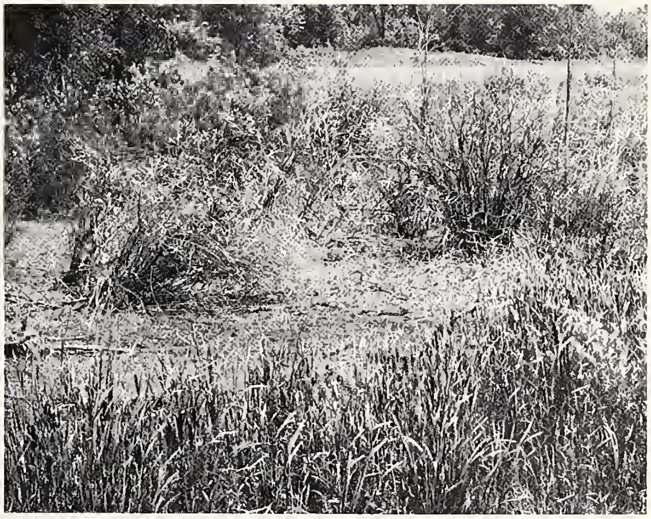


Figure 14. Floodplain of a river — potential breeding sites of *Psorophora* spp., *Aedes sticticus* and *Ae. vexans.*

FOURTH INSTAR LARVA (figs. 76-85) — *HEAD*: Either subquadrate (Subgenus *Psorophora*) or broadly rounded (Subgenera *Janthinosoma* and *Grabhamia*), wider than long; antenna either much shorter than head, sparsely spiculate and with a small, simple, inconspicuous seta (*Psorophora*) or at least length of head, spiculate and with a large multiple tuft (*Janthinosoma* and *Grabhamia*); head hairs 5-7 varying in length and branching. *ABDOMEN*: Comb scales usually few in number, in a single curved row, on a weakly-sclerotized plate in some species. *SIPHON*: Usually short, siphon index (ratio of length to width at middle) about 4.0; pecten teeth either numerous, long and hair-like, or short and few in number, located on basal half of siphon. Seta 1-S (siphon hair) inserted beyond middle, either very long and simple or very short to medium length and multiple. *SEGMENT X*: Completely ringed by saddle, dorsal surface of saddle with strong spicules in some species; seta 1-X (lateral hair) varying in length and branching; dorsal brush consisting of a pair of long, single lower caudal hairs and a pair of shorter, multiple upper caudal tufts; ventral brush well developed, piercing saddle along its ventral edge; anal papillae usually long, pointed.

KEYS TO SPECIES OF THE GENUS *PSOROPHORA*

FOURTH INSTAR LARVAE

1. Pecten with 18 or more teeth, each having a long, hairlike, terminal filament; seta 1-S (siphonal tuft) long, single (fig. 84); antenna short, slender, without a definite tuft (fig. 76) . . .(*Psorophora*) *ciliata*
   Pecten with fewer than 10 teeth, not long and hairlike; seta 1-S large and multiple, very small or obsolete; antenna long, stout, with definite tuft . . .2
2. Seta 1-S large, length of siphon; siphon not inflated (fig. 81) . . . .(*Grabhamia*) *discolor*
   Seta 1-S small, shorter than siphon, or obsolete; siphon at least somewhat inflated 3
3. Head hairs 5 and 6 with more than 3 branches (fig. 78) . . . .(*Grabhamia*) *columbiae*
   Head hairs 5 and 6 single, double, or occasionally triple . . . .(*Janthinosoma*)..4
4. Antenna much longer than median length of head (fig. 79) . . . . *ferox*
   Antenna subequal to median length of head . . .5
5. Siphon strongly inflated (width at widest point more than 3 times width at apex (fig. 82) . . . . *horrida*
   Siphon only slightly inflated (width at widest point less than 3 times width at apex (fig. 85) . . . . *mathesoni*

FEMALES

1. Wing scales mixed dark and white (fig. 100); hindfemur with narrow, subapical ring of white scales (fig. 96) . . . .(*Grabhamia*)..2
   Wing scales all dark or with a few white scales on costa and subcosta (figs. 102, 103); hindfemur without white ring 3
2. Segment 1 of hindtarsus mostly pale scaled (fig. 96); wing with definite pattern of dark and pale scales (fig. 101) . . . .*discolor*
   Segment 1 of hindtarsus with pale bands at base and middle (fig. 7); wing with dark and pale scales intermixed in no definite pattern (fig. 100) . . . . *columbiae*
3. Hindleg, including apex of femur, with long erect scales, appearing very shaggy; segment 5 of hindtarsus with some dark scales (fig. 93); large species (wing length 6.0 mm or more) . . . .(*Psorophora*) *ciliata*
   Apex of hindfemur without erect scales; hindleg not appearing shaggy, OR segment 5 of hindtarsus white-scaled; medium-sized species (wing length 4.0 mm or less) (fig. 95) . . . .(*Janthinosoma*)..4
4. Segment 5 of hindtarsus dark-scaled (fig. 95); mesono tum with broad, median stripe of dark scales (fig. 87) . . . .*mathesoni*
   Segment 5 of hindtarsus white-scaled (fig. 94); mesonotum variable 5
5. Mesonotum with mixed dark brown and yellowish white scales (fig. 88) . . . . *ferox*
   Mesonotum with a broad median stripe of dark brown scales, with pale yellow or grayish-white scales laterally (fig. 89) . . . .*horrida*

MALE TERMINALIA

1. Phallosome with lateral thorn-like projections near apex (fig. 104) . . . .(*Psorophora*) *ciliata*
   Phallosome without thorn-like projections 2
2. Gonostylus truncate; with claw inserted before apex (fig. 106) . . . .(*Janthinosoma*) *mathesoni*
   Gonostylus not truncate; claw inserted at apex . .3
3. Claspette about 0.75 times length of gonocoxite, with many feather-like setae on inner margin near apex and with a club-like filament and 2 broad, leaf-like filaments at apex (fig. 107) . . . . (*Janthinosoma*) *ferox*
   . . . . (*Janthinosoma*) *horrida*
   Claspette stem slender, club-shaped with 5-7 narrow, blade-like setae apically, no more than half the length of gonocoxite (*Grabhamia*). 4
4. Phallosome with a triangular projection on inner ventral margin of each plate (fig. 108). . . .*discolor*
   Phallosome lacking such triangular projections (fig. 105) . . . .*columbiae*

Subgenus *Grabhamia Theobald*

Grabhamia Theobald, 1903a. Mon. Cul. 3:243. TYPE SPECIES: *Culex jamaicensis* Theobald, by subsequent designation (Felt, 1904:391b).

Feltidia Dyar, 1905. Proc. Entomol. Soc. Wash. 7:47. TYPE SPECIES: *Culex jamaicensis* Theobald, by original designation.

Ceratocystia Dyar and Knab, 1906c. J. N.Y. Entomol. Soc. 14:183. TYPE SPECIES: *Culex discolor* Coquillett, by original designation.

Aedes, subgenus *Lanesia* Levi-Castillo, 1953. Rev. Ecuador Entomol. Parasitol. 1(3):102. TYPE SPECIES: *Aedes garciai* Levi-Castillo, by original designation.

Psorophora (Grabhambia) columbiae (Dyar and Knab)

Janthinosoma columbiae Dyar and Knab, 1906b. Proc. Biol. Soc. Wash. 19:135. Type-loc.: Grassymead, Virginia, United States.

Janthinosoma texanum Dyar and Knab, 1906b. Proc. Biol. Soc. Wash. 19:135. Type-loc.: Brownsville, Texas, United States.

Janthinosoma floridense Dyar and Knab, 1906b. Proc. Biol. Soc. Wash. 19:135. Type-loc.: Alligator Creek, Florida, United States.

Janthinosoma toltectum Dyar and Knab, 1906b. Proc. Biol. Soc. Wash. 19:135. Type-loc.: Tehuantepec, Oaxaca, Mexico.

IMPORTANT REFERENCE: Belkin et al., 1970:137 (provisional resurrection).

Belkin et al., in their monograph on the mosquitoes of Jamaica (1970), provisionally resurrected *Ps. columbiae* from synonymy with *Ps. confinnis* and applied this name to the populations of the *Ps. confinnis* complex from the eastern and southern United States and Grand Cayman Island. They considered *Ps. confinnis* to be restricted to South and Central America and Mexico.

DIAGNOSIS

FEMALE — SIZE: Moderate. *HEAD*: Proboscis dark-scaled with wide median band of pale yellowish scales; maxillary palpus dark with apex pale-scaled; occiput with pale whitish, appressed scales and dark, erect forked scales dorsally, with dorso-lateral patches of broad, flat, dark scales; torus light brown with patches of grayish-white scales on inner surface. *THORAX*: Mesonotum integument black, clothed with narrow, bronze to black scales, with submedian spots of bluish-white scales near the middle, in prescutellar space and on anterolateral angle; pleura with large patches of broad, appressed, whitish scales. *ABDOMEN*: Most terga dark-scaled with apical, median triangular or paired submedian patches of pale yellow scales; sternites with mixed dark and pale scales. *LEGS*: Tarsi with broad, basal white bands, reduced on segment 4 and lacking on segment 5 of fore- and midtarsi; hind basitarsus also with pale median band. *WING*: Length 4.0-4.5 mm; scales broad, intermixed brown and white in no definite pattern.

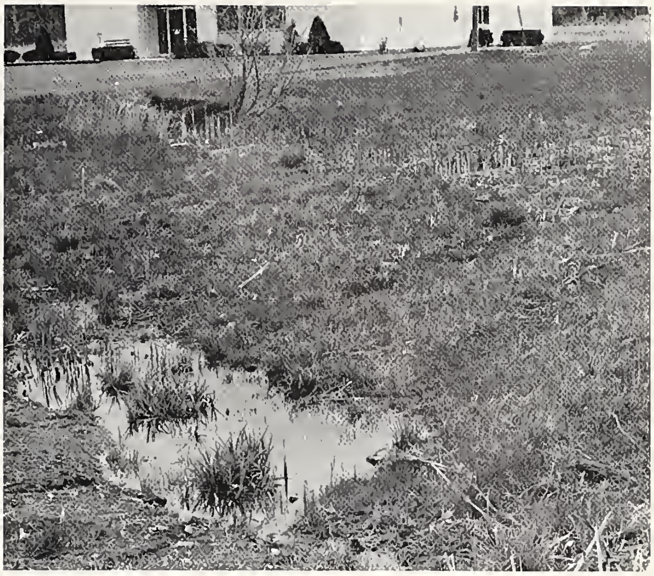


Figure 15. Reflooded temporary pool — a habitat for *Psorophora columbiae*.

MALE TERMINALIA (fig. 105) — *Lobes of tergum IX* bearing many fine setae. *Tergum X* heavily sclerotized with apical teeth. *Phallosome* cylindrical, bluntly pointed apically, open ventrally, closed dorsally. *Claspette* stem narrow, curved; expanded apically with 6-7 blade-like setae and one feathered, hair-like seta. *Gonocoxite* about 2.5 times longer than wide, clothed with setae and scales. *Gonostylus* about 0.6 times length of gonocoxite, expanded medially, tapered and curved apically; claw stout, inserted at tip.

FOURTH INSTAR LARVA — HEAD: Antenna shorter than head; seta 1-A long, multiple, near middle of antenna shaft; setae 5-7 multiple, barbed. *ABDOMEN*: Lateral hair 6 multiple on segments I and II, double on III-V, single on VI; comb scales 5 or 6, each thorn-shaped, with basal spines about 0.33 times length of median spine, located along posterior edge of a sclerotized plate. *SIPHON*: somewhat inflated, index about 3.0; pecten consisting of 3-6 widely spaced teeth on basal half of siphon. *SEGMENT X*: Seta 1-X small, about 0.5 times length of saddle, 2- 3-branched; anal papillae 2-3 times length of saddle, pointed.

BIONOMICS

Psorophora columbiae, often referred to in literature as *Ps. confinnis*, overwinters as eggs deposited on moist soil in depressions subject to inundation. Larvae are found in temporary ground pools which have dried and been refilled, such as those in pastures, roadside ditches, swales and overflow from streams and irrigation canals. Horsfall (1942) found them in enormous numbers in Arkansas in rice fields which had been drained and reflooded. They are most often found in open, unshaded places that contain emergent vegetation but sometimes occur in woodland pools if the canopy is high (Horsfall, 1955; Siverly, 1972). Curtis (1966) collected larvae from artificial containers, but this is an unusual habitat.

Overwintered eggs hatch in late spring or early summer, and larval development is rapid, requiring only 4-10 days in warm summer temperatures (Horsfall, 1942). There may be several generations a year, dependent only upon the frequency of inundation of eggs by water at summer temperatures. Larvae of *Ps. columbiae* have been found associated with those of *Ps. ciliata*, *Ps. discolor*, *Ps. cyanescens*, *Aedes atlanticus*, *Ae. sollicitans* and *Ae. vexans* in Indiana and Tennessee (Breeland et al., 1961; Siverly, 1972).

Female *Ps. columbiae* have been found to fly as far as 12 km across water in Delaware Bay (MacCreary and Stearns, 1937) and 9 km in rice fields (Horsfall, 1942). They feed all night, are attracted to light and invade dwellings in search of blood (Horsfall, 1955). They normally rest in tall vegetation near ground level during the day, but readily attack man or other animals that enter their resting areas. They are persistent biters and are considered a major pest of man and domestic animals in many areas of the south (Bishopp, 1933; Breeland et al., 1961; Carpenter and LaCasse, 1955; Horsfall, 1942, 1955; Hunter, 1910; King et al., 1939). Siverly (1972) reported that *Ps. columbiae* even attack people on bicycles or other vehicles, and have been collected biting man at a rate as high as 600 per hour in Tennessee (Breeland et al., 1961).

Horsfall (1955) reported that *Ps. columbiae* was a general feeder, attacking any warm-blooded animal. Whitehead (1951) found that it readily attacked cattle, horses, mules, and hogs, but rarely fed on birds. Edman and Downe (1964) found that, in addition to these hosts and man, *Ps. columbiae* fed naturally on chicken, sheep, dog and rabbit, and that multiple feedings on more than one host were common. This species has also been found to feed on the following warm-blooded animals in baited traps: Mammals: woodchuck, muskrat, raccoon, opossum, guinea pig; Birds: common egret, red-winged blackbird (Murphy et al., 1967). In these tests *Ps. columbiae* was not attracted to reptiles or amphibians.

DISTRIBUTION

Psorophora columbiae is distributed throughout most of the eastern and southern United States, west to Texas, Grand Cayman Island and northern Mexico. It is an economically important pest species in the southern United States, but is rare in New York where, except for a single specimen collected from Utica, it has been reported only from the southeastern part of the state.

IMPORTANCE

In the southern United States, where *Ps. columbiae* is more abundant, it is frequently a serious pest of man and livestock, occasionally killing cattle and other domestic animals from irritation and loss of blood (Bishopp, 1933). Two strains of California group arbovirus (CEV), St. Louis encephalitis (SLE) and Venezuelan equine encephalitis (VEE) have been isolated from this species (Murphey et al., 1971; Olson and Grimes, 1974). It was considered one of the most important vectors of VEE in a major outbreak in Texas in 1971 (Olson and Grimes, 1974; Sudia and Newhouse, 1971). Because *Ps. columbiae* is uncommon in New York it is rarely important, although it may occasionally become a nuisance in the southeastern counties, where it could also become important as a vector of several arboviruses.

Psorophora (Grabhamia) discolor (Coquillett)

Culex discolor Coquillett, 1903a. Can. Entomol. 35:256. Type- loc.: Delair, New Jersey, United States.

DIAGNOSIS

FEMALE — SIZE: Small. *HEAD*: Proboscis with a very wide band of pale yellow scales in center, dark brown scales at base and apex; maxillary palpus dark brown-scaled with a few pale scales at apex; occiput with golden yellow to silvery scales anteriorly and laterally, brown scales dorsally. *THORAX*: Mesonotum with fine, pale brown and silvery-gray to golden-yellow scales uniformly intermixed; pleura with patches of appressed, silvery-gray scales. *ABDOMEN*: Terga mostly pale-scaled with intermixed brown scales. *LEG*: Femur with intermixed pale and brown scales, a subapical ring of pale scales and white "knee spot"; tibia and basitarsus mostly pale-scaled with few intermixed brown scales; most other tarsal segments pale-scaled on basal half, dark-scaled on apical half. *WING*: Length 3.0-3.7 mm; predominantly scaled with rather broad pale scales, dark scales intermingled forming a long dark area on middle of costa, and many short areas scattered throughout wing on other veins.

MALE TERMINALIA: *Lobes of tergum IX* each with several long setae. *Tergum X* heavily sclerotized apically; margin smooth, without teeth. *Phallosome* cylindrical, rounded apically, closed dorsally, open ventrally, with a median triangular projection from ventral edge of each plate. *Claspette* stem slender, curved, expanded apically, with 5-6 long blade-like setae and one hair-like seta. *Gonocoxite* about 2.5 times longer than wide, clothed with scales and setae. *Gonostylus* about 0.6 times as long as gonocoxite, expanded medially, tapered and curved apically; claw stout, inserted at apex.

FOURTH INSTAR LARVA — HEAD: Antenna longer than head, thickened, spiculate; seta 1-A large, multiple, barbed, inserted near middle of antenna shaft; 2 long, dark, stout spines arising from a bend, or projection of antenna between seta 1-A and apex; head hairs 5 and 6 long, single, barbed; hair 7 long, double, barbed. *ABDOMEN*: Comb consisting of about 6 large scales in a curved row on a sclerotized area, each with a long median spine and shorter lateral spines. *SIPHON*: not inflated; siphon index about 3.0; pecten composed of 6-8 long scales on basal half; seta 1-S large, multiple, barbed, inserted just beyond middle of siphon; dorsal preapical spine curved, about length of diameter of siphon at apex. *SEGMENT X*: Seta 1-X single, about twice length of saddle; dorsal brush consisting of a 3- to 4-branched upper caudal hair and a longer, single lower caudal hair; ventral brush with 3 or 4 tufts piercing saddle; anal papillae 4 or more times length of saddle, with a trachea extending the full length of each.

BIONOMICS

Psorophora discolor has not been reported from New York but is included here because it occurs in neighboring New Jersey. This summary of the bionomics of *Ps. discolor* is taken largely from a detailed review by Horsfall (1955).

The life cycle of *Ps. discolor* is similar to that of *Ps. columbiae* (referred to in most literature as *Ps. confinnis*). *Psorophora discolor* overwinters as eggs deposited on the surface of the soil, where they are subject to inundation in early summer. Common oviposition sites include grassy depressions in open, unshaded pastures, ricefields (in Arkansas), and barnyards, especially on dried cow dung. Several generations can be produced annually where oviposition sites are alternately flooded and dried in the summer.

Larvae normally lie on the bottom of the pool, ventral side up, rarely coming to the surface, except just after hatching and just prior to pupation (Smith, 1904). Other species with which larvae of *Ps. discolor* are most often associated include *Ps. columbiae*, *Ps. ciliata*, *Anopheles punctipennis*, *An. quadrimacu latus* and *Culex erraticus*. Larval development generally requires 10-14 days, somewhat longer than *Ps. columbiae*, and about two days are required for pupal development.

Adult females are a troublesome pest of man and livestock, especially at night, when they fly in search of blood, but also during the day in the vicinity of their resting places. Cattle and other large mammals are apparently the principal hosts (Whitehead, 1951).

DISTRIBUTION

The range of *Ps. discolor* extends from New Jersey south and west to New Mexico and into Mexico. It is considered uncommon through most of its range except in Arkansas, Oklahoma and Texas, where it is abundant, especially in rice growing areas of Arkansas.

IMPORTANCE

Because *Psorophora discolor* has not been reported from New York and it is considered uncommon throughout most of its range, it is of no importance at this time in the State. However, Jamestown Canyon virus (CEV group) has been isolated from this species and it should be considered of potential importance as a possible vector (Sudia et al., 1971).

Subgenus *Janthinosoma* Lynch-Arribalzaga

Janthinosoma Lynch-Arribalzaga, 1891a. Rev. Mus. La Plata 1:374; 2:152. TYPE SPECIES: *Culex discrucians* Walker, by subsequent designation (Dyar, 1905:47).

Conchyliastes Theobald, *In* Howard, 1901. Mosquitoes: 155, 235. TYPE SPECIES: *Culex musicus* Say, by subsequent designation (Coquillett, 1910:526).

Ianthinosoma Lynch-Arribalzaga, *In* Goeldi, 1902. Os Mosquitoes no para en cardos como uma calamidade publica:9 (emend.).

Lepidosia Coquillett, 1906a. Science 23:314. TYPE SPECIES: *Culex cyanescens* Coquillett, by original designation.

IMPORTANT REFERENCE: Guedes and Souza, 1964:471 (key).

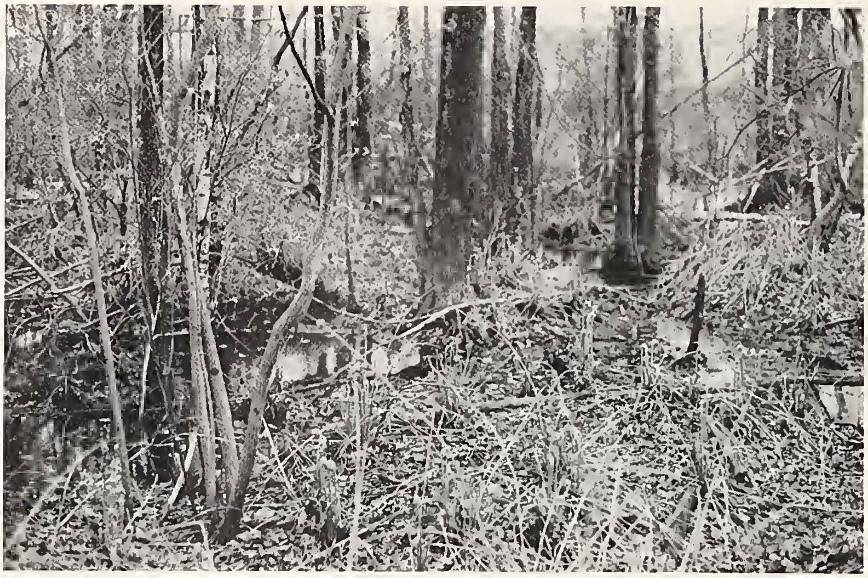


Figure 16. A wooded floodplain subject to spring and summer flooding — habitat for larvae of *Psorophora ferox*, *Ps. mathesoni* and other species.

Psorophora (Janthinosoma) ferox (Humboldt)

Culex ferox Humboldt, 1819. Voy. Reg. Equin. 2(7):340. Type- loc.: Borodon, Ecuador.

Culex posticatus Wiedemann, 1821. Dipt. Exot.: 43. Type-loc.: Mexico.

Culex musicus Say, 1829. J. Acad. Sci. Philadelphia 6:149. Type-loc.: Indiana, United States.

Janthinosoma echinata Grabham, 1906. Can. Entomol. 38:311. Type-loc.: Molynes Road, near Kingston (Surrey), Jamaica.

Janthinosoma sayi Dyar and Knab, 1906c. J. N.Y. Entomol. Soc. 14:181. (*nom. nov.* for *musicus* Say, *non* Leach).

Janthinosoma terminalis Coquillett, 1906b. Tech. Ser. U.S. Bur. Entomol. 11:8, 17. Type-loc.: St. Lucia Island, (Lesser Antilles).

Janthinosoma vanhalli Dyar and Knab, 1906a. Proc. Biol. Soc. Wash. 19:134. Type-loc.: Paramaribo, Surinam.

Janthinosoma coquillettii Theobald, 1907. Mon. Cul. 4:153, 154. Type-loc.: none designated.

Janthinosoma sayi Theobald, 1907. Mon. Cul. 4:155. (*nom. nov.* for *musicus* Say, *non* Leach).

Janthinosoma sayi var. *jamaicensis* Theobald, 1907. Mon. Cul. 4:157. Type-loc.: Runaway Bay and Kingston (Surrey), Jamaica.

Aedes pazosi Pazos, 1908. An. Acad. Habana 45:432. Type-loc.: Vuelto Abajo (Las Villas), Cuba.

Janthinosoma centrale Brethes, 1910. An. Mus. Nac., B. Aires 20:469. Type-loc.: Isles del Parana, Buenos Aires, Argentina.

DIAGNOSIS

FEMALE — SIZE: Moderate. *HEAD*: Proboscis dark-scaled; occiput with yellowish to white scales dorsally; broad, appressed, yellowish scales laterally; yellow, erect, forked scales posteriorly. *THORAX*: Mesonotum integument black, with dark brown and yellowish to whitish scales intermixed in no definite pattern; pleura with large, dense patches of grayish-white, appressed scales. *ABDOMEN*: Most terga dark-scaled with a purplish reflection dorsally, with apicolateral triangular patches of pale scales; venter mainly pale-scaled, dark-scaled on terminal segments. *LEG*: Fore- and midlegs all dark-scaled; segments 4 and 5 of hindtarsus pale-scaled; scales suberect, appearing shaggy, with a purplish reflection. *WING*: Length 3.7- 4.0 mm; scales narrow, dark.

MALE TERMINALIA — Lobes of tergum IX rounded, with several long setae. *Tergum X* sclerotized and with teeth at apex. *Phallosome* conical, pointed apically, open ventrally, closed dorsally. *Claspette* about 0.75 times length of gonocoxite, expanded apically, with 2 leaf-like filaments and a small rod- like filament at apex and several long, subapical, feathered filaments or setae. *Gonocoxite* about 3.5 times longer than wide, clothed with scales and setae. *Gonostylus* expanded medially; *claw* stout, inserted at apex.

FOURTH INSTAR LARVA — HEAD: Antenna longer than head, spiculate; seta 1-A large, multiple, barbed, inserted at about middle of antenna shaft; head hairs 5 and 6 long, usually double, hair 7 long, multiple. *ABDOMEN*: Comb with 6-8 scales in a row along posterior margin of a weakly sclerotized area, each scale thorn-like with large basal spines about 0.33 times length of central spine. *SIPHON*: Siphon inflated near middle; siphon index about 4.0; pecten of 3-5 teeth widely separated on basal fourth of siphon; seta 1-S very small, multiple, inserted beyond middle of siphon. *SEGMENT X*: Seta 1-X a very small multiple tuft; dorsal brush a long single lower hair and shorter multiple upper tuft; ventral brush extending nearly entire length of segment, piercing saddle; anal papillae much longer than saddle, sharply pointed.

BIONOMICS

Eggs of *Ps. ferox* are deposited on moist soil in wooded depressions and shaded floodplains of rivers and streams, usually under leaves and other forest residue. Overwintered eggs hatch in late June or early July in Indiana and thereafter throughout the summer whenever flooded, but only after a period of drying (Horsfall, 1955; Siverly, 1972). Larvae are found in temporary woodland pools and in shaded roadside ditches and floodplains, especially in pools lined with leaves. Unlike larvae of other mosquito species, *Ps. ferox* larvae do not "wriggle" but rather "sail" through the water with the aid of their mouthbrushes. They also are able to remain at the bottom of the pool for extended periods of time to feed, where they often secret themselves under leaves and other debris, making it difficult to collect them (Horsfall, 1955; Siverly, 1972). Larval development is rapid (8-10 days in Indiana) with the number of generations being produced in a season dependent upon the amount and frequency of rainfall. Adults are rarely found away from their sylvan breeding sites, although they do sometimes follow hosts out of the woods into sunny areas, and have been collected up to 2 km from the nearest possible source (Horsfall, 1955). They normally rest on the underside of the leaves of low-growing plants in the vicinity of their origin. Although they do not actively seek blood but, rather, lie in ambush for hosts, they are aggressive and persistent biters and attack man and other animals that enter their resting places any time of day or night. After taking a blood meal the female develops a single batch of eggs and usually dies within a day or two after depositing them (Horsfall, 1955).

DISTRIBUTION

This species is distributed throughout most of eastern United States, South and Central America, and the Greater Antilles (Knight and Stone, 1977). It has been reported once from Canada (Wood et al., 1979). It is rare in New York, and except for one record from Ithaca (Tompkins County), it has been recorded only from the southeastern part of the State (Barnes et al., 1950; W. G. McClure, pers. comm.).

IMPORTANCE

Psorophora ferox is an important pest species in the southern parts of its range, where it often occurs in great abundance, especially following floods (Horsfall, 1955). In addition, females have been found to carry eggs of the Torsalo fly, *Dermatobia hominis*, to vertebrate hosts in South America (Bates, 1943), and California group arbovirus has been isolated from females in Florida (Sudia et al., 1971) and New Jersey (Murphey et al., 1971). In addition, Hayes and Corristan (1972) found that *Ps. ferox* was susceptible to infection by Bunyamwera group viruses. Because it is rare in New York it is not considered to be of any importance, although it could become a local nuisance, especially in the southeastern area of the state, and could act as a vector of California encephalitis virus.

Psorophora (Janthinosoma) horrida (Dyar and Knab)

Aedes horrida Dyar and Knab, 1908a. Proc. U.S. Nat. Mus. 35(1632):56. Type-loc.: Corinth, Mississippi, United States.

IMPORTANT REFERENCE: Matheson, 1934 (resurrected from synonymy with *Ps. champerico*).

DIAGNOSIS

FEMALE — SIZE: Moderate. *HEAD*: Proboscis and maxillary palpus dark purple-scaled; occiput clothed with pale yellow to white scales except for small dorsolateral patches of purplish scales. *THORAX*: Mesonotum clothed laterally and in prescutellar space with pale yellow to grayish-white scales, with a broad median stripe of dark brown scales; scutellum with pale scales and dark setae; pleura with patches of whitish scales. *ABDOMEN*: Most tergites purplish-scaled with pale yellow apicolateral patches. *LEG*: Mostly dark-scaled, except basal half of hind- femur, at least two tarsal segments of hind leg, and knee spots on all femora pale-scaled; many scales on legs semi-erect, giving a shaggy appearance. *WING*: Length 3.7-4.0 mm; uniformly dark-scaled.

MALE TERMINALIA — Indistinguishable from *Psorophora ferox*.

FOURTH INSTAR LARVA — HEAD: Antenna about length of head, spiculate; seta 1-A multiple, inserted at about middle of antenna shaft; head hairs 5-7 with 2 or more branches, subequal in length. *ABDOMEN*: Comb with 6-10 thorn-shaped teeth in a curved row. *SIPHON*: Strongly inflated; siphon index 3.5-4.0; pecten with 3-5 widely separated teeth before middle of siphon; seta 1-S very small, approximately length of apical pecten tooth, inserted midway between pecten and apex of siphon. *SEGMENT X*: saddle complete; seta 1-X very small, multiple; dorsal brush a short upper multiple tuft and a long lower caudal hair; ventral brush extending nearly length of saddle; anal papillae 2-3 times length of saddle, pointed.

BIONOMICS

Eggs of *Psorophora horrida* are deposited in depressions or scattered on the soil surface, usually in wooded areas, and generally require "ripening," or a period of drying, before hatching (Carpenter and LaCasse, 1955). Overwintered eggs hatch in late April or May in the Tennessee Valley (Breeland et al., 1961) and probably about a month later in Indiana (Siverly, 1972). According to Horsfall (1955), the biology and habits of the immature stages are similar to those of *Ps. ferox* and the information cited for that species applies also to *Ps. horrida*. Larvae are found in temporary woodland pools that fill following heavy summer rains. Larval development is rapid and the adults of a given generation emerge almost simultaneously (Carpenter and LaCasse, 1955).

Females of *Ps. horrida* rest on vegetation in woods near the larval sites, readily attacking any warm-blooded animals, including man, that invade their haunts during the day or night. They are described as fierce biters that are frequently serious local pests where they are abundant. The hosts of *Ps. horrida* have not been studied in detail, but Horsfall (1955) reported that feeding habits appear to be similar to those of *Ps. ferox*. Several blood meals may be sought by *Ps. horrida*, however, in contrast to one or only a few by *Ps. ferox* (Roth, 1945).

DISTRIBUTION

Psorophora horrida is distributed throughout central and southeastern United States, west to Nebraska and north to Ohio, Pennsylvania and Michigan (Zaim et al., 1977). It has not been reported from New York or the New England states, but its range may extend to these states.

IMPORTANCE

Although this species is considered an important pest species in the southern states, it has not been incriminated in the transmission of diseases. Because it has not been reported from New York, it is not considered of any importance here at this time.

Psorophora (Janthinosoma) mathesoni (Belkin and Heinemann)

Psorophora (Janthinosoma) mathesoni Belkin and Heinemann, 1975. Mosq. Syst. 7:363. Type-loc.: Florence, Alabama.

DIAGNOSIS

FEMALE — *SIZE*: Moderate. *HEAD*: Proboscis and maxillary palpus dark-scaled; occiput with appressed yellowish to yellowish-white scales dorsally, dark purplish-brown scales laterally; torus dark with pale scales on inner surface. *THORAX*: Mesonotum with a broad median stripe of dark brown scales; pale yellowish-white scales on lateral margins and in prescutellar space; pleura with large areas of dingy-white appressed scales. *ABDOMEN*: First tergite pale-scaled; remaining terga dark-scaled except for pale scales at apicolateral angles. *LEG*: Mostly dark-scaled; basal portion of femur and at least part of fourth tarsal segment of hindleg pale-scaled. *WING*: Length 3.0-3.5 mm; scales narrow, dark.

MALE TERMINALIA (fig. 106) — *Lobes of tergum IX* with many long setae. *Tergum X* sclerotized and with teeth apically. *Claspette* about 0.75 times length of gonocoxite; dorsoventrally flattened; claw-like at apex; with several setae, some smooth, some feathered, near middle. *Phallosome* conical, open ventrally, closed dorsally. *Gonocoxite* with scales and setae. *Gonostylus* with many small hairs; truncate at tip; *claw* peg-like, inserted before apex.

FOURTH INSTAR LARVA — *HEAD*: Antenna about length of head, spiculate; seta 1-A multiple, barbed, inserted at about middle of antenna shaft; head hairs 5 and 6 long, 2- 3-branched; hair 7 long, multiple. *ABDOMEN*: Comb with 6-7 scales in a V-shaped row, each scale thorn-like with subapical spines about 0.25 times length of median spine. *SIPHON*: Siphon somewhat inflated; siphon index about 4.0; pecten of 2-4 small teeth widely separated on basal third of siphon; seta 1-S small, multiple, inserted beyond middle of siphon. *SEGMENT X*: seta 1-X very small, single or branched distally; dorsal brush a long single lower hair and a shorter multiple upper tuft; anal papillae usually more than twice length of saddle, sharply pointed.

BIONOMICS

Overwintered eggs of *Ps. mathesoni* hatch when flooded with warm water. In Illinois this normally does not occur until late June or July (Horsfall, 1955). Although larval development is rapid and there may be more than one generation a year (Siverly, 1972), Horsfall states that there is rarely more than one generation in the northern part of its range. Larvae occur in temporary shaded woodland pools, especially on the floodplains of streams in swampy lowlands and usually among floating mats of debris such as twigs and leaves (Buren, 1946).

The females of *Ps. mathesoni* are described as persistent, troublesome biters which readily attack man and large mammals, including cattle and pigs, anytime during the day in woodlands and in pastures and grasslands at night (Horsfall, 1955; Siverly, 1972).

DISTRIBUTION

Psorophora mathesoni is distributed from New Jersey west to Texas and throughout the southeastern United States (Belkin and Heinemann, 1975; Knight and Stone, 1977; O'Neill et al., 1944). It has been reported only once from New York, (as *Ps. varipes*), a female taken while biting on Staten Island, Richmond County (Barnes et al., 1950). It seems likely that the specimen had been brought out of its range to the area, perhaps by a ship.

IMPORTANCE

Although this species is sometimes considered a severe nuisance in the South, it has not been incriminated in disease transmission. Since it has been reported only once from New York, the northern limit of its range, it is not considered of any importance in New York or the Northeast.

Subgenus *Psorophora* Robineau-Desvoidy

Psorophora Robineau-Desvoidy, 1827. Mem. Soc. Hist. Nat. Paris 3:412. TYPE SPECIES: *Culex ciliatus* Fabricius, by subsequent designation (Theobald, 1901a:263).

Psorophora (Psorophora) ciliata (Fabricius)

Culex ciliata Fabricius, 1794. Syst. Entomol. 4:401. Type-loc.: vicinity of Ten Mile Station, Charleston County, South Carolina, United States.

Culex cyanopennis Humboldt, 1819. Voy. Reg. Equin. 2(7):340. Type-loc.: Magdelena R. Columbia.

Culex molestus Wiedemann, 1820. Dipt. Exot.: 7. Type-loc.: Georgia, United States.

Culex rubidus Robineau-Desvoidy, 1827. Mem. Hist. Nat. Paris 3:404. Type-loc.: vicinity of Ten Mile Station, Charleston County, South Carolina, United States.

Culex tibialis Robineau-Desvoidy, 1827. Mem. Soc. Hist. Nat. Paris 3:404. Type-loc.: Rio de Janeiro, Guanabara, Brazil.

Culex boscii Robineau-Desvoidy, 1827. Mem. Soc. Hist. Nat. Paris 3:413. Type-loc.: vicinity of Ten Mile Station, Charleston County, South Carolina, United States.

Culex conterrens Walker, 1856. Ins. Saund. Dipt.: 427. Type-loc.: vicinity of Ten Mile Station, Charleston County, South Carolina, United States.

Psorophora lynchi Brethes, 1916. An. Mus. Nac. B. Aires 28:204. Type-loc.: Argentina.

Psorophora ctites Dyar, 1918b. Insec. Inscit. Menst. 6:126. Type-loc.: Brownsville, Texas, United States.

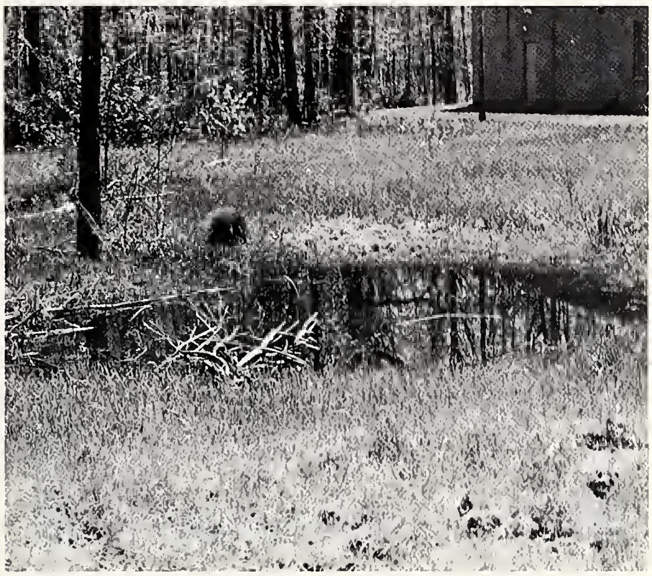


Figure 17. Temporary pool habitat for larvae of *Psorophora ciliata*, *Culex* spp., *Aedes vexans*, *Ae. sticticus* and other multivoltine and floodwater species.

DIAGNOSIS

FEMALE — *SIZE*: large. *HEAD*: Proboscis with suberect, dark brown scales on basal half, mixed dark brown and yellowish scales medially, dark at tip; maxillary palpus with dark brown to black, suberect scales; occiput with broad, appressed grayish scales dorsally, with a median bare stripe; numerous dark setae anteriorly, pale yellowish erect, forked scales posteriorly; lateral region without scales but with numerous brown setae; torus brown, without scales. *THORAX*: Mesonotum dark brown, with a narrow median stripe of pale golden scales; submedian stripes, partially nude, partially with dark brown scales and setae; prescutellar and lateral patches of yellowish to white scales; pleura with patches of grayish-white scales. *ABDOMEN*: Most terga covered with pale yellow to brown scales. *LEG*: Femur pale with dark, erect scales at apex, tibia dark-scaled except for narrow basal band of pale scales; hindtarsal segments with pale basal bands, fore and midtarsi with segments 1-3 pale basally, dark apically; segments 4 and 5 all dark; most scales on leg, especially dark scales, erect or suberect, giving a shaggy appearance. *WING*: Length 6.0-6.7 mm; scales narrow, brown; a few pale scales on anterior veins.

MALE TERMINALIA — Lobes of tergum IX with many long setae. *Tergum X* heavily sclerotized and with teeth apically. *Claspette* expanded into a flattened crown apically; with a broad, hook shaped filament and several setae on the expanded portion. *Phallosome* conical, with a tooth-shaped triangular projection from each plate near apex. *Gonocoxite* about 2.5 times longer than wide, rounded at apex; clothed with scales, long and short setae. *Gonostylus* curved; with several short setae and an angular projection on apical half; *claw* short, peg-like, inserted at apex.

FOURTH INSTAR LARVA — HEAD: Quadrate and concave anteriorly; broader than long; antenna less than half as long as head; seta 1-A short, single, inserted past middle of antenna shaft; prehensile mouth brush hairs each with a row of comblike teeth; head hair 4 long, single; hairs 5-7 single, branched distally. *ABDOMEN*: Comb with 10-16 scales in a curved row, each scale thorn-like with basal spines about 0.3 times length of median spine. *SIPHON*: Gradually tapered, not inflated; siphon index 3.0 to 4.0; pecten with long hair-like teeth on basal half of siphon, each with 1 or 2 very short basal teeth; seta 1-S a long single hair inserted beyond pecten. *SEGMENT X*: seta 1-X with 3-4 branches arising from near base, shorter than saddle; dorsal brush a long single lower hair and a short multiple upper tuft; ventral brush short, extending nearly full length of anal segment, piercing saddle; anal papillae at least 3 times length of saddle, pointed.

BIONOMICS

Overwintered eggs all hatch within a few hours of each other after being conditioned by drying, and reflooded with warm water in early summer (Horsfall, 1955). Eggs are deposited on moist soil under surface debris and in depressions and small cracks, most often in pastures and fields but also in wooded areas. Schwardt (1939) and Carpenter and LaCasse (1955) reported that eggs probably do not hatch until after a winter in hibernation. However, Horsfall (1955), Siverly (1972) and others reported that this species may have several generations hatching a year, depending upon the frequency and amount of summer rains.

Larvae are found in all types of transient pools, most often in open, sunlit, grassy pools and roadside ditches. Larval development is rapid, usually requiring only 4-5 days in Indiana (Siverly, 1972). Associated species include several other multivoltine and floodwater species, including other *Psorophora* species, *Culex* species, *Aedes vexans*, *Ae. trivittatus*, *Ae. sticticus* and others (Horsfall, 1955). Larvae are predacious and cannibalistic in the last three instars, preying on larvae of any associated mosquitoes by hanging motionless from the water surface and impaling victims with their mandibular teeth as they drift or wiggle by. As many as ten mosquito larvae a day can be devoured by a single *Ps. ciliata* larva (Carpenter and LaCasse, 1955; Horsfall, 1955; Siverly, 1972).

Female *Ps. ciliata* are persistent and vicious biters and will attack any time during day or night, especially in open fields and at dusk. Ross (1947) described the females as almost "terrifying" because of their large size and "business-like appearance." The author has also found that this species is formidable because of the deliberate manner with which it attacks. Its hosts include man and other large mammals such as livestock (Siverly, 1972).

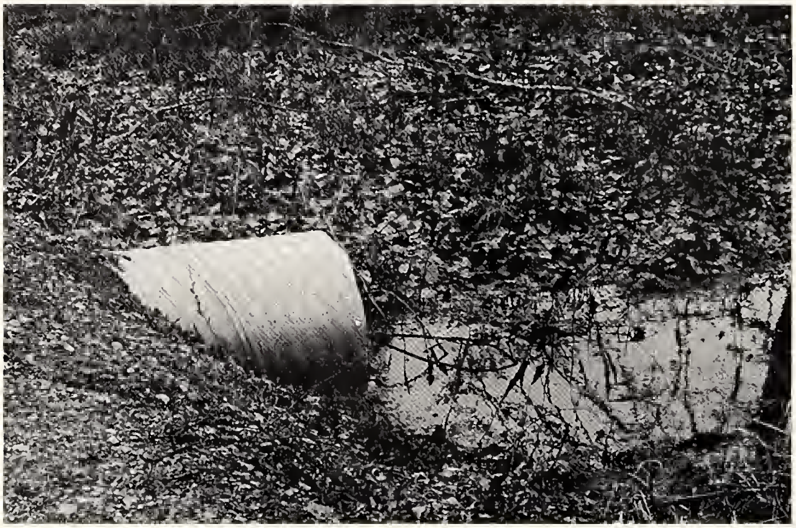


Figure 18.a. ***Psorophora ciliata*** **larvae may sometimes be found in temporary pools, where they prey on** ***Aedes vexans*** **and other species.**

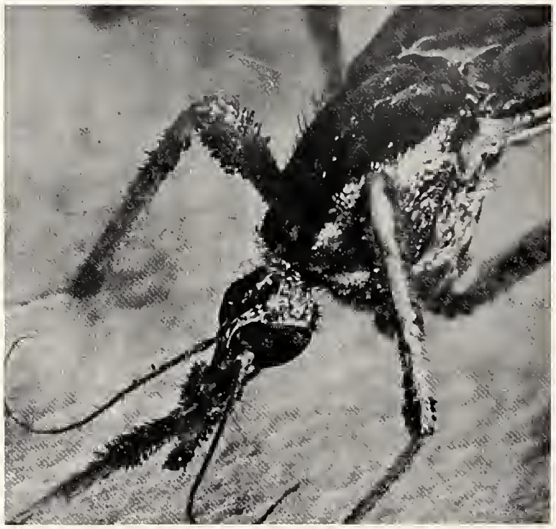


Figure 18.b. ***Psorophora ciliata*** **is a persistent biter.**

DISTRIBUTION

Psorophora ciliata is distributed throughout much of southern Canada, the United States east of the Rocky Mountains, Mexico, Central and South America. It has been reported from scattered localities throughout New York State (Barnes et al., 1950), but is seldom found in abundance in the State. Since 1975 there have been an increasing number of localized infestations reported from the eastern part of the State, especially in the Hudson River Valley south of Albany and east of Lake George along the Champlain Barge Canal.

IMPORTANCE

Psorophora ciliata has not been incriminated in the transmission of disease organisms, and is seldom found in abundance, therefore is of no known medical importance. It is, however, a persistent and painful biter, and should be considered important locally as a pest species.

Tribe Culicini

Knight (1978), Knight and Stone (1977) and Ward (1984) list three genera, *Culex*, *Deinocerites* and *Galindomyia* and 797 species, subspecies and varieties in the tribe Culicini. Only the genus *Culex* is represented in New York.

Genus *Culex* Linnaeus

Culex Linnaeus, 1758. Syst. Nat., 10th ed. 1:602. TYPE SPECIES: *Culex pipiens* Linnaeus, by subsequent designation (Latrielle, 1810:422).

The genus *Culex* is one of the largest genera of Culicidae, with 778 recognized species, subspecies and varieties in 21 subgenera (Knight, 1978; Knight and Stone, 1977; Ward, 1984). This genus is nearly worldwide in distribution, with the majority of species occurring in tropical and subtropical regions. Three subgenera, *Culex*, *Neoculex* and *Melanoconion*, are represented in the United States. Three species in the subgenus *Culex* and one in *Neoculex* are common in New York; a fifth species, *Cx.* (*Culex*) *tarsalis*, is primarily western in distribution, but has been reported from Pennsylvania and New Jersey (Lesser et al., 1977), and a sixth, *Cx.* (*Melanoconion*) *erraticus* is found just south of New York in Delaware, District of Columbia and Maryland, and further west at the same latitude in Ohio, Michigan and North Dakota.

Culex species in the United States generally have the "*Culex pipiens*" type of life cycle in which adult females overwinter, eggs are deposited in rafts on the water surface, and there are several generations a year (Pratt, 1959). All New York species apparently exhibit this type of life cycle, although in Massachusetts (Main et al., 1968) *Cx. territans* is reported to have the univoltine "*Culiseta impatiens*" type of life cycle, as it apparently does in Alaska and other northern parts of its range (Frohne, 1954; Gjullin et al., 1961; Pratt, 1959).

Eggs are deposited vertically on the water surface in boatlike "rafts" of several eggs attached together. The number of individual eggs in a raft varies from about 30 to more than 300, depending upon the species (or subspecies), the time of year and whether or not the eggs were developed autogenously (with the female not having had a bloodmeal). Autogenous rafts and rafts deposited late in the season usually contain fewer eggs than those laid during the peak of the season.

Larvae of *Culex* are found in a wide variety of temporary and permanent aquatic habitats including saline water, clear spring water, rain water in natural and artificial containers and in polluted water of high organic content. They are often extremely abundant, especially when found in heavily polluted water such as that in barnyards, duck or poultry farms and sewage treatment plants. The adults of most New York species normally feed on birds and cold-blooded animals rather than mammals and are not usually pests of man.

DIAGNOSIS

FEMALE (figs. 120-143) — *HEAD*: Proboscis either darkscaled or with median pale band; maxillary palpus usually not more than 0.2 times as long as proboscis; occiput with narrow curved scales dorsally, broad appressed scales laterally and sometimes on anterior margin, color pattern varying with species; erect forked scales on occiput usually numerous, sometimes obscurring recumbent scales. *THORAX*: Mesonotal scales predominantly fine, narrow, usually rather uniformly colored, brown to golden brown, sometimes with submedian spots of darker or lighter scales; pleura usually with reduced patches of whitish to yellowish scales; prespiracular and postspiracular setae absent; lower mesepimeral setae present or absent. *ABDOMEN*: First tergite usually with median patch of pale scales, most of remaining terga normally dark-scaled with basal and sometimes apical bands of white to yellow scales, terminal segments often entirely pale-scaled; segment 8 bluntly rounded, not retracted within segment 7. *LEG*: Primarily dark-scaled in most species, sometimes with metallic reflection; tarsi of most New York species unbanded (tarsal segments of *Cx. tarsalis* with basal and apical bands); tarsal claws simple. *WING*: Cell R2 longer than vein R2 + 3; subcosta without distinct bristles at base on ventral surface; scales narrow, all dark in most species; sometimes with a few pale scales on costa.

MALE TERMINALIA (figs. 137-143) — *Lobes of tergum IX* variable. *Tergum X* with many short tooth-like spines apically. *Claspette* absent. *Phallosome* a pair of sclerotized plates variable in form. *Gonocoxite* variable in form, with long setae on outer aspect, sometimes with smaller setae on inner aspect; *basal lobe* absent; *subapical lobe* bearing spines and setae of various modifications. *Gonostylus* variable.

FOURTH INSTAR LARVA (figs. 109-119) — *HEAD*: Wider than long; antenna usually longer than head, either tapering gradually or constricted beyond middle, often strongly curved; seta 1-A well developed and inserted beyond middle of antenna shaft; head hairs 5-7 variable in length and branching. *THORAX*: Prothoracic hairs 1-7 variable in length and branching. *ABDOMEN*: Comb of segment 8 usually with many scales (30 or more) in a triangular patch; sometimes fewer in a single row. *SIPHON*: Siphon usually long, sometimes 8-10 times longer than wide; pecten teeth usually evenly spaced, not reaching middle of siphon; several ventral and lateral hairs, single and/or multiple, the number, position and branching variable. *SEGMENT X*: Completely ringed by saddle; seta 1-X usually shorter than saddle, single or multiple; dorsal brush consisting of a pair of long single lower caudal hairs and a pair of upper caudal hairs, usually at least double, the branches variable, single in some species; ventral brush well developed, consisting of several branched hairs; anal papillae variable in length, even within a species, depending on salinity of water.

Figure 19. Collecting *Culex pipiens* larvae and eggs from overflow pools near a river.

KEYS TO SPECIES OF THE GENUS *CULEX*

FOURTH INSTAR LARVAE

1. Antenna nearly uniform in shape with seta 1-A near middle; siphon with 3-4 pairs long, single (occasionally double) setae and 1 pair short, 2- or 3-branched setae; dorsal brush with 2 long, simple hairs on each side (fig. 41) . . . . *restuans*
   Antenna constricted beyond seta 1-A on distal third of shaft (fig. 110); siphon with 3 or more pairs of branched setae; dorsal brush a single hair and a branched hair on each side (fig. 113). 2
2. Head hairs 5 and 6 multiple, subequal in length (fig. 109) 3
   Head hair 6 long, single or double; hair 5 long, single *OR* half as long as 6, multiple (fig. 111, 112) 5
3. Siphon with 5 pairs of multiple tufts in a straight line, most with 6 or more branches; siphon index about 6; seta 1-X with 2 or more branches (fig. 116) . . . . *tarsalis*
   Siphon with one or more tufts usually inserted laterally out of line; tufts usually with 4 or fewer branches; siphon index variable; seta 1-X usually single 4
4. Siphon index 3-6; anal papillae variable (Pl. XXI); head hairs 5 and 6 usually with 4 or more branches (fig. 109). . . . . *pipiens*
   Siphon index more than 6, usually at least 8; anal papillae usually short, bud-like; (fig. 118); head hairs 5 and 6 usually 3- 4-branched (fig. 110) . . . . *salinarius*
5. Head hairs 5 and 6 long, single or double (fig. 112); comb with about 30 scales in a patch, individual scale without a long terminal spine (fig. 117) . . . . *territans*
   Head hair 5 half the length of hair 6, with 5 or more branches (fig. 111); comb with less than 30 scales in a double irregular row; individual scale with a long terminal spine (fig. 119) . . . . *erraticus*

FEMALES

1. Proboscis and tarsi with bands of pale scales (fig. 120, 124); mesonotum with stripes of white scales (fig. 126). . . . . *tarsalis*
   Proboscis and tarsi entirely dark; mesonotum without stripes 2
2. Abdominal terga with pale apical bands or with apicolateral patches, without pale basal bands (fig. 134) . . . . *territans*
   Abdominal terga without apical bands or patches, with or without basal bands or basolateral patches 3

3. Eyes bordered with dingy, broad, appressed scales (fig. 130); scales on veins R_2 and R_3 short and wide, contrasting with long narrow scales of Rs (fig. 125); abdominal sternites with broad pale basal bands (fig. 135) . . . . *erraticus*
   Eyes not bordered with appressed scales; all wing scales long and narrow; abdominal sternites uniformly pale or with scattered dark scales, sometimes forming indistinct longitudinal center line (fig. 136) 4
4. Abdominal terga with narrow, dingy yellow, basal bands, sometimes inconspicuous or absent, segments VII and VIII often entirely covered with dingy yellow scales (fig. 133) . . . . *salinarius*
   Terga with conspicuous, bright white, basal bands, bands of middle segments usually wide 5
5. Mesonotum with fine scales, usually with a few white scales forming a pair of spots near middle (fig. 128); tibial knee spots usually prominent (fig. 122) basal abdominal bands each with posterior margin straight across segment and broadly joining lateral patches (fig. 132) . . . . *restuans*
   Mesonotum covered with coarse scales, without pale spots near middle (fig. 127); tibial knee spots usually moderate (fig. 121); basal abdominal bands broadly rounded on posterior margin and constricted laterally, narrowly joining or entirely disconnected from lateral patches (fig. 131) . . . . *pipiens*

MALE TERMINALIA

1. Gonocoxite short, globular; subapical lobe divided into 3 long stalks (fig. 137) . . . . *erraticus*
   Gonocoxite elongate, tapering distally; subapical lobe only slightly divided, if at all 52
2. Middle phallosomal plate with a cluster of stout sclerotized teeth 3
   Middle phallosomal plate not toothed. 4
3. Lateral arm of inner phallosomal plate expanded apically; middle plate with basal projection curved and up under teeth, and without a plate paralleling inner plate (fig. 138). . . . . *salinarius*
   Lateral arm of inner phallosomal plate narrow, bladelike, paralleled by a blade of the middle plate; basal projection of middle plate projecting only laterally (fig. 139) . . . . *tarsalis*
4. Inner and middle phallosomal plates not distinct, represented as a single structure. 5
   Inner phallosomal plate forming a "V" or "U"-shaped structure; middle phallosomal plate terminating in a strongly-curved process 6
5. Middle phallosomal plate terminating on each side with a pair of stout teeth or rods; brush of tergum X bushy (fig. 140). . . . . *restuans*
   Middle phallosomal plate terminating on each side in a round serrate knob; brush of tergum X with short heavy comb-like teeth (fig. 141) . . . . *territans*
6. Rods of inner phallosomal plate divergent, together forming a V-shaped structure (fig. 142) . . . . *pipiens*
   Rods of inner phallosomal plate convergent, together forming a U-shaped structure (fig. 143). . . . . *quinquefasciatus*

Subgenus *Culex* Linnaeus

Culex Linnaeus, 1758. Syst. Nat., 10th ed. 1:602. TYPE SPECIES: *Culex pipiens* Linnaeus, by subsequent designation (Latreille, 1810:442).

Heteronycha Lynch-Arribalzaga, 1891a,b. Rev. Mus. La Plata 1:373, Rev. Mus. La Plata 2:155. TYPE SPECIES: *Heteronycha dolsa* Lynch-Arribalzaga, by monotypy.

Lasioconops Theobald, 1903b. Mem. Liverpool Sch. Trop. Med. 10:8. TYPE SPECIES: *Lasioconops poicilipes* Theobald, by monotypy.

Heptaphlebomyia Theobald, 1903a. Monogr. Culicidae, vol. 3:336. TYPE SPECIES: *Heptaphlebomyia simplex* Theobald, by monotypy.

Pseudohetaphlebomyia Ventrillon, 1905. Bull. Mus. Hist. Nat., Paris: 427. TYPE SPECIES: *Pseudoheptaphlebomyia madagascariensis* Ventrillon, by monotypy.

Trichopronomyia Theobald, 1905a. Ann. Hist. Nat. Mus. Hung. 3:98. TYPE SPECIES: *Trichopronomyia annulata*, by monotypy.

Aporoculex Theobald, 1907. Monogr. Culicidae, vol. 4:316. TYPE SPECIES: *Aporoculex punctipes* Theobald, by monotypy.

Leucomyia Theobald, 1907. Monogr. Culicidae, vol. 4:372. TYPE SPECIES: *Culex gelidus* Theobald, by original designation.

Oculeomyia Theobald, 1907. Monogr. Culicidae, vol. 4:515. TYPE SPECIES: *Oculeomyia sarawaki* Theobald, by monotypy.

Theobaldiomyia Brunetti, 1912. Rec. Indian Mus. 4:462. TYPE SPECIES: *Culex gelidus* Theobald, by autonomy.

Phalangomyia Dyar and Knab, 1914. Insec. Inscit. Menst. 2:58. TYPE SPECIES: *Phalangomyia debilis* Dyar and Knab, by monotypy.

Laiomyia Izquierdo, 1916. Tesis, Col. Est. Puebla: 65. TYPE SPECIES: *Culex stigmatosoma* Dyar, by subsequent designation (Edwards, 1932:200).

Culex, subgenus *Transculicia* Dyar, 1917 (1918). Insec. Inscit. Menst. 5:184. TYPE SPECIES: *Culex* (*Transculicia*) *eluthera* Dyar, by monotypy.

Culex, subgenus *Cacoculex* Dyar, 1918a. Insec. Inscit. Menst. 6:100. TYPE SPECIES: *Culex* (*Cacoculex*) *habilitator* Dyar and Knab, by original designation.

IMPORTANT REFERENCES: Bram, 1967 (classification); Cupp and Ibrahim, 1973 (classification).

Culex (Culex) pipiens Linneaus

Culex pipiens Linneaus, 1758. Syst. Nat., 10th ed. 1:602. Type-loc.: Europe; Lapponia; America.

Culex consobrinus Robineau-Desvoidy, 1827. Mem. Soc. Hist. Nat. Paris 3:408. Type-loc.: Pennsylvania, United States.

Culex molestus Forskal, 1775. Descript. Anim. 85. Type-loc.: Rosetta, Cairo and Alexandria, Egypt.

For complete synonymy see Harbach et al. (1984), Knight and Stone (1977:216-220) and Knight (1978:45-46).

IMPORTANT REFERENCES: Sirivanakarn, 1976: 30, 35 (change of status of subspecies *pipiens* and subspecies *quinquefasciatus* to full species). Harbach et al., 1984:540 (*Cx. molestus* Forskal considered a behavioral physiological variant of *pipiens*, without nomenclatorial status).

The classification followed in this paper for *Culex pipiens* and *Cx. quinquefasciatus* is that recognized by Knight (1978) and Harbach et al. (1984). According to this classification, two species of the *Culex pipiens* complex are recognized in North America; the holarctic *Cx. pipiens*, common in New York, and the cosmotropical (encircling the world in tropical and warmer temperate climates) *Cx. quinquefasciatus* (formerly referred to as *Cx. fatigans*), which does not occur in New York. *Culex molestus*, locally abundant in New York, is now considered a behavioral/ physiological variant of *Cx. pipiens* (Harbach et al., 1984) and no longer has taxonomic status.

DIAGNOSIS

FEMALE — *SIZE*: Moderate. *HEAD*: Proboscis and maxillary palpus dark-scaled. Occiput with narrow, yellowish to goldenbrown scales dorsally, broad, whitish scales laterally. *THORAX*: Mesonotum and scutellum uniformly clothed with narrow, curved golden-brown scales; scutellum also with light brown setae; pleura with small areas of white scales. *ABDOMEN*: Most terga clothed with dark scales having a metallic blue-green appearance; with basal bands and lateral patches of pale scales; the bands usually convexly rounded and narrowed where they join lateral patches on *Cx. pipiens*, sometimes more broadly joined on *Cx. quinquefasciatus*. Sternites mostly pale-scaled, often with a few dark scales intermixed. *LEG*: Primarily dark-scaled with a metallic blue-green appearance; pale scales at apices and on posterior aspects of femur and tibia. *WING*: Length 3.5-4.0 mm; scales narrow, dark.

MALE TERMINALIA — *Lobes of tergum IX* rounded, widely separated, with several long fine setae. *Tergum X* with numerous short spines at apex, *basal arm* usually a short finger-like protuberance. *Phallosome* consisting of 2 sclerotized plates joined at the base; each plate with a curved, outwardly tapered, pointed *ventral arm*, which is narrower and more strongly sclerotized in *Cx. pipiens* than in *Cx. quinquefasciatus*; a similar ventral process smaller than the ventral arm near middle of plate; and a *dorsal arm* crossing over the ventral arm (crossing obliquely in *Cx. pipiens*, at a 90° angle in *Cx. quinquefasciatus*). The ratio of the distance between the dorsal arm and the ventral arm to the distance between the two dorsal arms can sometimes be used to separate the subspecies (Sunderaraman, 1949). *Gonocoxite* about 2.5 times longer than wide; *subapical lobe* prominent, with 3 long and one shorter rod-like setae, the longer 3 hooked at tip; 3 long, fine setae, 2 hooked at tip; and a broad leaf-like filament. *Gonostylus* about 0.5 times length of gonocoxite, curved, with 2 subapical setae; claw short, blunt, inserted at apex.

FOURTH INSTAR LARVA — *HEAD*: Antenna shorter than head, spiculate before seta 1-A, constricted and sparsely spiculate beyond seta; seta 1-A large, multiple, barbed, inserted beyond middle, extending beyond apex of shaft; head hairs 5-7 long, multiple, barbed. *THORAX*: Prothoracic hairs 1-3 long, single. *ABDOMEN*: Comb with numerous scales in a patch, each clubshaped and clothed with fine spinules. *SIPHON*: Siphon index about 4.0; pecten with about 5-15 evenly spaced teeth before middle, followed by four setae, the subapical seta inserted laterally, apical and subapical setae usually 2- 3-branched, the others usually multiple. *SEGMENT X*: Seta 1-X single, nearly as long as saddle; dorsal brush a long lower caudal hair and two shorter upper caudal hairs; ventral brush well-developed, on barred area only; anal papillae varying greatly in length, usually about 1.0-1.5 times length of saddle, pointed.

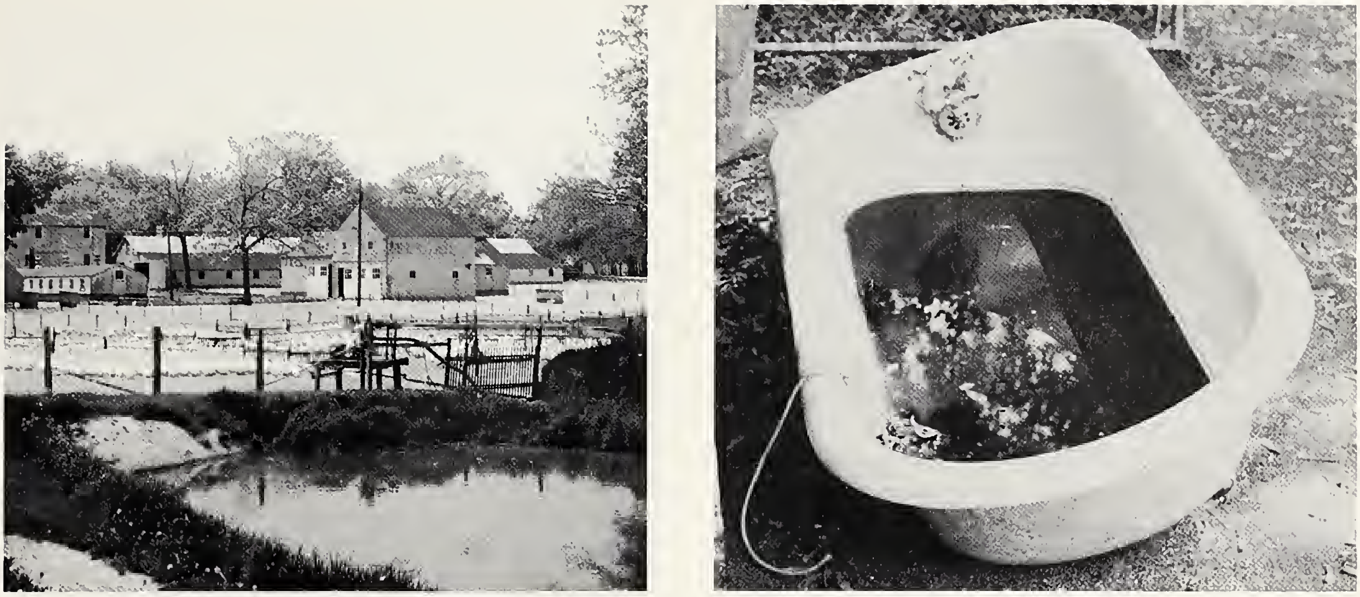


Figure 20. ***Culex pipiens*** **typically breeds in abundance in several types of habitats; a. Duck and poultry farms, b. Artificial water-holding containers.**

BIONOMICS

There are several differences in the bionomics of autogenous and anautogenous *Cx. pipiens*, both of which occur in New York. Since these forms are often indistinguishable, many of the records available are based on biological rather than morphological differences. The biologies of all North American members of the *Cx. pipiens* complex have been reviewed by Horsfall (1955).

In general, adult females emerge from overwintering sites in late spring and begin to deposit eggs in rafts on the water surface. The mechanics of oviposition have been described in detail by Reamur (1738) and summarized by Horsfall (1955). The first raft of eggs deposited by overwintered autogenous *Cx. pipiens* may be autogenous, then a blood meal must be obtained prior to production of additional eggs (Shute, 1951). Tate and Vincent (1936) have shown that autogeny is an inherited characteristic that not all *pipiens* females exhibit, and the percentage of autogenous females increases with successive generations in a colony which has been maintained autogenously. It has also been found that F1 hybrids from autogenous x anautogenous crosses produce a percentage of autogenous females in their F2 generation (Knight, 1951; Vincent, 1933). Autogenous egg rafts are normally smaller (10-30 eggs) than anautogenous rafts produced by *Cx. pipiens* or by other members of the *Cx. pipiens* complex (usually 50-200 eggs) (Jobling, 1938).

Under summer field conditions in New York eggs hatch in 2 to 3 days, larvae develop to maturity and pupate in 9 to 12 days and adults emerge in 2 to 3 days. Early and late in the season and during unseasonably cool weather in the summer, development may take up to three times longer. Similar developmental periods have been found for members of the *Cx. pipiens* complex throughout the world (Horsfall, 1955).

Larvae of *Cx. pipiens* are found in a variety of habitats, ranging from clear grassy ponds and woodland pools to artificial containers such as water barrels, discarded tires and wells, to heavily polluted pools in barnyards, duck farms, sewage treatment plants and other places that contain water of high organic content. They are found in fairly deep water such as roadside ditches, rock pools near streams and wells, and also in habitats as small as rain-filled hoof prints in barnyards.

Although autogenous *Cx. pipiens* have been reported from some areas of the world to be more tolerant than anautogenous *Cx. pipiens* to polluted water (Knight, 1951), this does not appear to be so in New York. There are many records, especially from Europe, of the *molestus*-form larvae normally occurring in foul water, especially in urban situations (e.g., cesspools). However, larvae which appear morphologically to be the "*molestus*" larvae described by Burbutis and Jobbins (1963) have been collected from clear woodland pools on Long Island, in the Adirondacks and from marshes in western New York. Further, adults reared from these larvae have exhibited autogeny, stenogamy (the ability to mate in a small area) and have fed on the blood of small mammals and man, all traits typical of the *molestus* variant.

In contrast, the form of *Cx. pipiens* which is most common and abundant throughout the State normally breeds in water that is high in organic content. These larvae have the morphological characteristics of the "*pipiens*" described by Burbutis and Jobbins (1963). Adults reared from these larvae have been found to be anautogenous (unable to develop eggs without having a blood meal) and eurygamous (not able to mate in a small area). They only rarely bite mammals, even when starved, all traits of typical *Cx. pipiens*.

Breeding of *Cx. pipiens* is continuous throughout the summer, with a peak in early August, then a gradual decline until frost, when suitable overwintering sites are sought. It has been reported that autogenous *Cx. pipiens* is less resistant to low temperatures than the anautogenous *Cx. pipiens*, and is able to survive in central Europe and England due only to its invasion of heated places (Knight, 1951). In New York State, the *molestus* form females have likewise been found overwintering only in such places as dark heated basements, subways and bunkers, while typical *Cx. pipiens* females have been found overwintering in cooler locations, such as caves, unheated basements and wells. Overwintering *molestus* form females are fairly active, but typical *Cx. pipiens* are very sluggish. The latter have been observed to migrate gradually from the ceiling to the walls, then to the floor of overwintering sites as the winter temperatures drop, then back to the walls and to the ceiling as temperatures rise near the end of the winter (unpublished data).

Because both immature and adult *Cx. pipiens* are often extremely abundant near habitations wherever there is standing water in practically any form, this species is often referred to as the "house mosquito" and reported to bite man readily. Actually, *Cx. pipiens* feeds primarily on birds and rarely attacks man, although Reeves and Hammon (1944) found that 24% took their second blood meal from mammals. The *molestus* form, which breeds in basements, subways and similar dark, heated places, in addition to woodland pools, feeds on many animals, including man (Shute, 1949). Since the autogenous form of *pipiens* appears to be relatively uncommon in New York State north of New York City, much of the annoyance attributed to this species may actually be caused by *Cx. restuans*, a similar species that is easily mistaken for *Cx. pipiens*.

DISTRIBUTION

Culex pipiens is one of the most widely distributed of all mosquitoes, occurring throughout the world between the latitudes of 60° N and 40° S (Mattingly et al., 1951). Since there are no consistent morphological differences between autogenous and anautogenous *Cx. pipiens* populations (Harbach et al., 1984), most distribution records are based on characters of autogeny, stenogamy, and host preference.

Culex pipiens occurs throughout the United States except in the extreme south, where it is replaced by *Cx. quinquefasciatus*, Say. It is common in most of New York State, except in the northernmost counties, where it is less common and abundant. It is locally abundant in areas where there is water of high organic content, such as sewage treatment plants, duck farms and other barnyards, and vegetable processing plants. The autogenous variant occurs throughout the range of *Cx. pipiens*, although it is more abundant in warmer regions of the world. In New York State, what appear to be the *molestus* form have been collected as adults and larvae from a few locations on Long Island, from subway tunnels in New York City, and rarely from marshes in Genesee, Hamilton and Essex Counties.

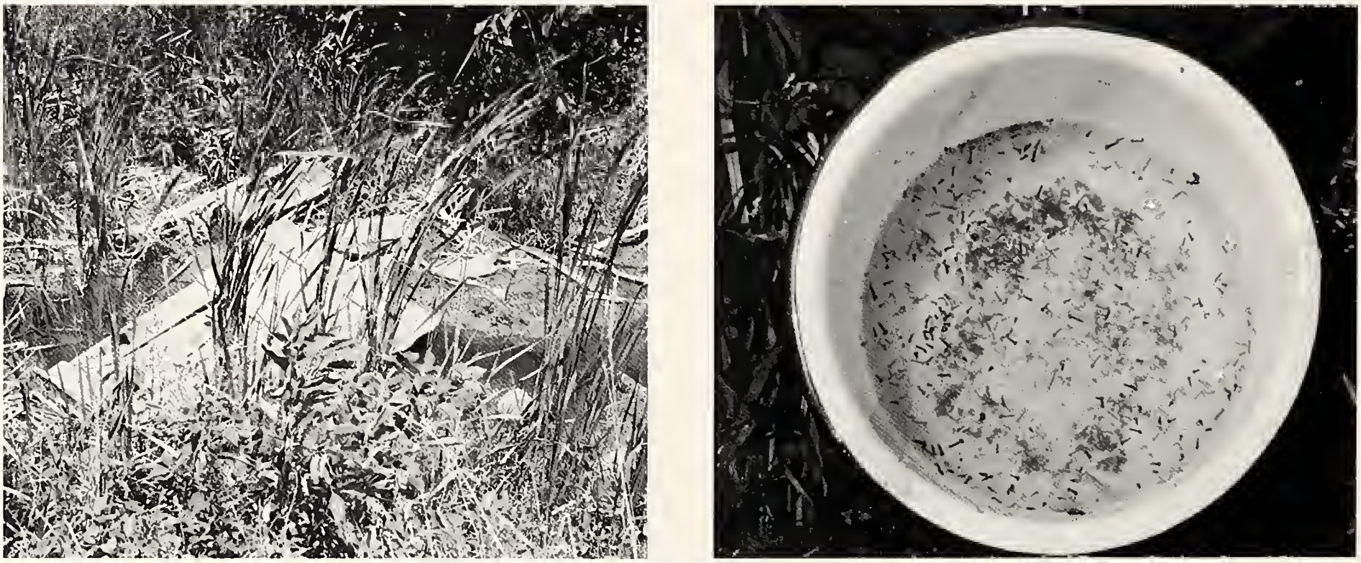


Figure 21. Very large quantities of mosquito larvae may often be found in certain breeding situations; a. A debris-clogged drainage ditch creates breeding sites for *Culex pipiens*, *Cx. restuans* and other species, b. A dipper containing *Cx. pipiens* larvae from the site in fig. 21a.

IMPORTANCE

Although this species occurs throughout most of New York, it rarely bites man or other mammals. Most reports of this occurrence probably refer instead to *Cx. restuans*, a species that is easily confused with, and often indistinguishable from, *Cx. pipiens*. Therefore, the importance of *Cx. pipiens* as a pest species or as a vector of human disease is apparently minimal in this state. However, the viruses of eastern, western, St. Louis, and California encephalitis have been isolated from this species (Clark et al., 1977; Hammon and Reeves, 1945; Hammon et al., 1945a; Sudia et al., 1971) and *Cx. pipiens* may serve as an important vector of these and other disease organisms to birds, both wild and domestic, which it commonly feeds upon. Wherever the species abounds on duck, poultry and other farms and barnyards, it should be considered a potential vector of these, and probably other, diseases to the domestic birds as well as to migratory and resident wild birds in the area. Transmission of these viruses from one bird population to another in this manner enhances the possibility of the same viruses being transmitted to mammals, including man, by a mosquito vector having more general feeding habits. Therefore, *Cx. pipiens* should also be considered a potential secondary vector in the transmission of viruses and other diseases to mammals. *Culex pipiens* is also capable of transmitting *Dirofilaria immitis* (heartworm) to dogs (Carpenter and La-Casse, 1955) although this is probably a rare occurrence with the avian-feeding habits of this species in New York State.

Culex (Culex) restuans Theobald

Culex restuans Theobald, 1901c. Mon. Cul. 2:142. Type-loc.: Toronto, Ontario, Canada.

Culex brehmei Knab, 1916. Proc. Biol. Soc. Wash. 29:161. Type-loc.: Newark, New Jersey, United States.

DIAGNOSIS

FEMALE — SIZE: Medium. *HEAD*: Proboscis dark-scaled, occasionally with a few white scales intermixed on ventral surface; maxillary palpus dark-scaled; occiput with narrow yellowish-white to light golden-brown scales dorsally, broad, appressed white to yellowish-white scales laterally and bordering eyes; dark-brown, erect, forked scales usually very numerous and conspicuous dorsally, often concealing narrow, pale scales; torus light to dark brown, bare. *THORAX*: Mesonotum sparsely-clothed with fine narrow, golden-brown scales, silvery-white to pale gold in prescutellar space and usually on lateral margins; a pair of submedian spots of somewhat coarser, white scales, ranging from one to about 15 scales usually present near middle of mesonotum, sometimes inconspicuous or absent, especially on late-breeding specimens; pleura with small patches of broad, white to yellowishwhite scales. *ABDOMEN*: Terga dark-scaled with basal bands of white scales usually about 0.25 times width of segment, sometimes indented medially, usually broadly-joined to pale basolateral patches; sternites mostly pale-scaled, sometimes with a few dark scales medially. *LEG*: Dark-scaled with a metallic blue-green reflection; tarsi occasionally with faint yellowish-brown bands. *WING*: Length 3.0-4.0 mm; scales narrow, dark.

MALE TERMINALIA — Lobes of tergum IX rounded, widely separated, with several setae. *Tergum X* with a dense crown of short spines; *basal arm* a long, curved finger-like projection. *Phallosome* consisting of 2 sclerotized plates joined basally, each with an apical *ventral arm*, ventral triangular projection, and basal *dorsal arm*, curved outwardly and over the basal arm of tergum X. *Gonocoxite* 2.0-2.5 times longer than wide; *subapical lobe* undivided, bearing three long, hooked rod-like setae; 2 shorter setae, one hooked; and a broad, leaf-like filament. *Gonostylus* 0.5 times length of gonocoxite, curved, with 2 short subapical setae; claw peg-like, apical.

FOURTH INSTAR LARVA — HEAD: Antenna tapered, shorter than head, spiculate, darker on apical half; seta 1-A multiple, inserted near middle of shaft; head hairs 5-7 multiple, barbed. *THORAX*: Prothoracic hairs 1-3 subequal, long, single (occasionally double). *COMB*: Many club-shaped scales in a patch, each with numerous long, fine spinules covering the surface. *SIPHON*: Siphon index 4.0-5.0; pecten with about 10-20 evenly spaced teeth on basal 0.33 of siphon; 3 long, single and one shorter 2- 3-branched setae irregularly placed beyond pecten. *SEGMENT X*: Saddle complete, with small spicules at dorsoapical corner; seta 1-X single or double, about length of saddle; anal papillae usually 2-3 times length of saddle, pointed.

BIONOMICS

The immature stages of *Culex restuans* are found in a variety of aquatic habitats and have been collected from water in a wide range of purity including clear woodland pools; rock pools in river beds; natural and artificial containers such as treeholes, hollow stumps, barrels, watering troughs and discarded tires; sewage disposal plants and water polluted with dead animals and slaughter wastes (Barr, 1958; Gjullin and Eddy, 1972; Horsfall, 1955; Matheson, 1944; Rees, 1943; Rempel, 1953). The

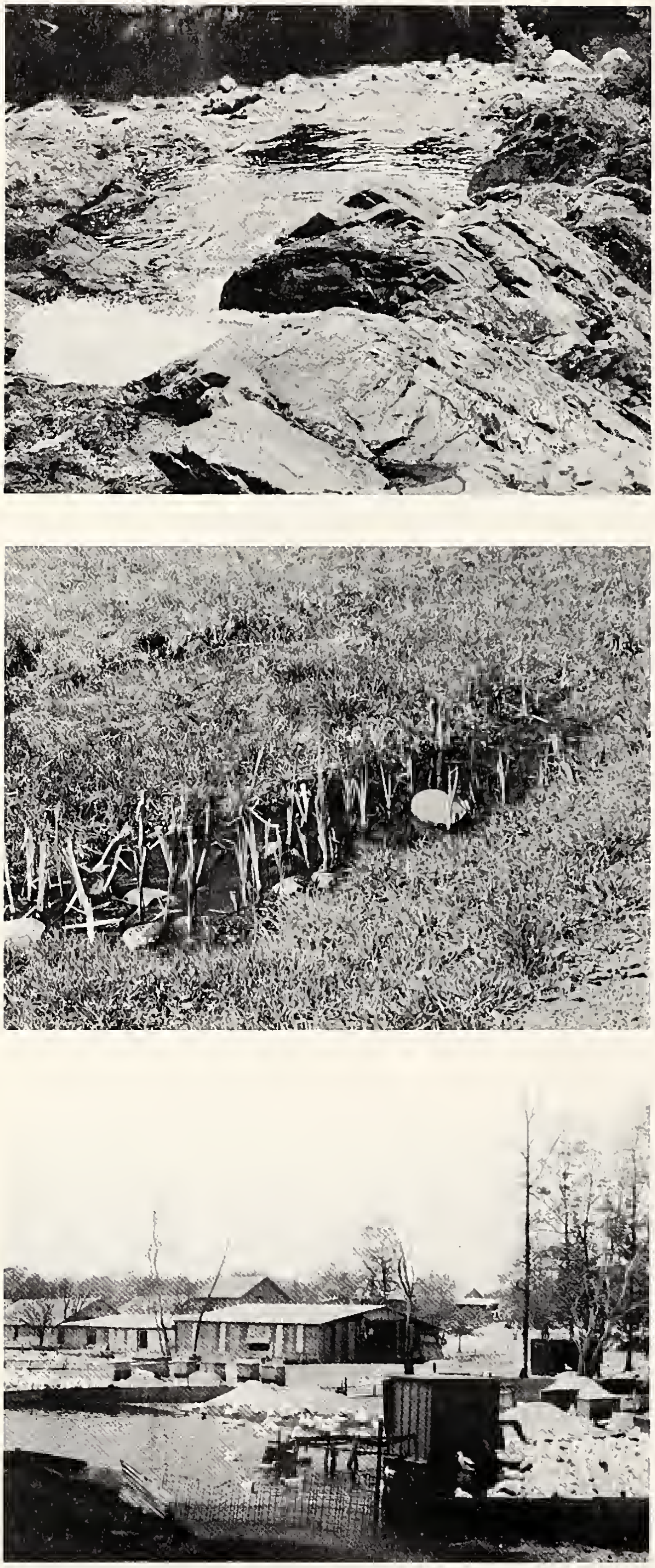


Figure 22. *Culex restuans* larvae are commonly found in a variety of habitats: a. Clear, fresh water in rock pools near mountain streams, b. Grassy pools and roadside ditches, c. Heavily polluted pools on farms and sewage plants.

author has commonly collected larvae from all of these habitats, especially from heavily polluted duck and poultry farms and sewage treatment plants, from artificial containers such as discarded tires and buckets containing rain water, and from grassy roadside ditches and pools. Larvae have also been collected from water heavily treated with chlorine on Long Island duck farms, and saline pools in a stream bed near a salt mine in central New York.

Egg rafts are normally laid on the water surface by overwintered females beginning about mid-May at lower elevations in New York State and about a week later in mountainous regions. First instar larvae have been collected from Long Island duck farms as early as May 10, in the Albany area as early as May 20 and in the Adirondacks as early as May 25. Mullen (1970) reported collecting egg rafts in Tompkins County on May 21. The length of time required for development of the immature stages varies with temperature and the supply of organic material. Barr (1958) reported the length of time required for development is about the same as that for *Cx. pipiens*, i.e., 7-10 days at warm temperatures. The author has found that in water containing abundant organic matter at 72-75° F, eggs hatch in 1-2 days, larvae develop to maturity in 6-7 days and the pupal stage lasts 1-2 days. Under the same conditions in water containing little organic matter, larvae require 3-4 weeks to develop to maturity and are usually much smaller, sometimes only half the size of larvae developing in water of high organic content. The resulting adults are also much smaller than adults produced from the larger larvae. Larvae of *Cx. restuans* are commonly associated with larvae of *Cx. pipiens*, *Cx. territans* and *Culiseta melanura* in New York. Mullen (1970) has also collected them with *Aedes canadensis* and the author has occasionally found them with larvae of *Cx. salinarius* and *Ae. dorsalis* in saline habitats.

There is disagreement concerning the feeding requirements and preferences of female *Cx. restuans*. Mayne (1922) stated they fed only on vegetable matter and Thibault (1910) said they fed on livestock and poultry, but not on man. Dyar (1928) considered them to be troublesome biters, replacing *Cx. pipiens* in the northern woods as the house mosquito, and McLintock (1944) referred to this species (as *Cx. territans*) as the third most important pest species in the greater Winnipeg area. Barr (1958) reported that *Cx. restuans* does not normally bite man but can become annoying when abundant. Wright and DeFoliart (1970) and Murphey et al. (1967) found this species would engorge on a number of small mammals but preferred birds; Hayes (1961) and Means (1968) found that this species engorged equally as well on both birds and mammals.

It is the author's opinion, after several years of observation, that although the females of *C. restuans* apparently prefer birds and large wild and domestic animals to man, they can be quite annoying to man, especially when they are emerging from hibernation in the spring. Females have often been collected biting on warm spring evenings. Some of the confusion over whether or not this species bites man is probably because of misidentification of *Cx. pipiens* as *Cx. restuans* and *vice versa*. Often the mesothoracic spots of white scales are rubbed off old specimens of *Cx. restuans*, causing them to resemble *Cx. pipiens*. Also, these white scales are frequently reduced or absent even in fresh specimens, especially in adults emerging from larvae which develop in cold water late in the season. These late-breeding individuals are those which hibernate and subsequently emerge from hibernation in spring. In addition, *Cx. pipiens* specimens frequently have bare (rubbed) areas on the mesothorax which appear to be white spots, thereby causing them to be misidentified as *Cx. restuans*.

DISTRIBUTION

Culex restuans occurs in southern Canada, Mexico and throughout the United States, although it is most common in the eastern and midwestern states and rare from Colorado westward. It is common throughout New York State and the entire northeastern United States.

IMPORTANCE

The viruses of eastern encephalitis (Hayes et al., 1960) and western encephalitis (Norris, 1946) have been isolated from wild caught *Culex restuans* females. Since the species is especially common in the vicinity of duck farms and other barnyards, where it feeds readily on domestic and wild birds, it is a likely vector of these viruses to flocks of domestic birds and may well be involved in maintaining the viruses in wild and domestic birds. Since *Cx. restuans* is known to feed at least to some extent on man and other mammals, it should be considered a potential vector of encephalitis viruses from birds to mammals, including man.

Culex (Culex) salinarius Coquillett

Culex salinarius Coquillett, 1904b. Entomol. News 15:73.
Type-loc.: Elizabeth, New Jersey, United States.

DIAGNOSIS

FEMALE — *SIZE*: Moderate. *HEAD*: Proboscis and maxillary palpus dark-scaled; occiput with pale, golden-brown scales and dark, erect scales dorsally, grayish scales laterally. *THORAX*: Mesonotum uniformly covered with golden-brown scales; pleura with several small patches of grayish scales. *ABDOMEN*: Most terga dark-scaled with metallic bronze-brown scales and narrow to moderate basal bands of pale scales; terga VII and VIII often pale-scaled. *LEG*: Dark-scaled except posterior surfaces of femur and tibia pale scaled. *WING*: Length 3.5-4.0 mm; veins with narrow, dark scales.

MALE TERMINALIA — *Tergum VIII* with many long, heavy setae. *Lobes of tergum IX* broadly rounded, widely separated, with many fine setae. *Tergum X* with a crown of numerous short spines; *basal arm* a long, curved, finger-like projection. *Phallosome* composed of 2 sclerotized plates joined at base, each with a stout, pointed, apical *ventral arm*; a median group of stout, pointed teeth; and basal *dorsal arm* curved outwardly and ventrally over basal arm of phallosome. *Gonocoxite* about 2.5 times longer than wide; subapical lobe undivided, bearing 3 long, stout, hooked, rod-like setae; 2 more slender setae, one hooked; and a broad, leaf-like filament. *Gonostylus* half length of gonocoxite, curved, with 2 short subapical setae; *claw* peg-like, apical.

FOURTH INSTAR LARVA — *HEAD*: Antenna about length of head or shorter, pale before seta 1-A, constricted and darker beyond seta; seta 1-A large, multiple, inserted beyond middle of shaft; head hairs 5-7 long, multiple, barbed. *ABDOMEN*: Comb with many apically rounded scales in a patch, each fringed with small spinules. *SIPHON*: Siphon index 6.0-7.0; pecten with 10-20 teeth on basal 0.25 of siphon; 4-5 long, 2- 4-branched setae inserted irregularly beyond pecten, subapical seta lateral. *SEGMENT X*: Saddle complete, seta 1-X single or double, nearly length of saddle; dorsal brush a long lower caudal hair and an upper caudal tuft of one long hair and 2 shorter hairs; anal papillae 1-2 times length of saddle, bluntly pointed.

BIONOMICS

Females overwinter in dwellings and other protected places and lay egg rafts on the water surface, much the same as females of *Cx. pipiens* do, beginning in late spring and continuing through the summer. Mitchell (1907) reported that egg rafts contained 50-55 eggs, but Newkirk (1955) found up to 104 eggs in a raft. Probably Mitchell had observed only partial rafts because they disintegrate rapidly and complete rafts are rarely found (Headlee, 1945). Half-grown larvae can be found on Long Island by early June, therefore, egg rafts must be deposited by mid-

May. Farther north and inland, larvae are not usually collected until mid-June. The length of time necessary for development from egg to adult is about 2-3 weeks in warm weather (Mitchell, 1907; Wallis and Spielman, 1953), and there are several generations during the summer months.

According to Dyar and Knab (1906c) *Cx. salinarius* is inappropriately named because the larvae do not occur in salt water. Headlee (1945), however, reported that the larvae are common "everywhere on the marsh in salt as well as fresh water...". Dyar and Knab (1906c), Mitchell (1907), Horsfall (1955), Barr (1958) and others report that this species is most common in freshwater ground pools, especially in marshy areas. The author has not collected this species from saline water, but has found it in fresh pools immediately adjacent to salt marsh on Long Island. Carpenter and LaCasse (1955) reported that the species breeds in both clean and foul water in microhabitats as small as cattle tracks. Larvae are also commonly collected from natural and artificial containers such as stump holes, rain barrels and boats as well as from streams (Carpenter and LaCasse, 1955; Dyar, 1922; Rozeboom, 1942). The author has collected larvae from deep, grassy roadside ditches; from artificial containers, including milk cans being used for decoration and discarded tires; as well as from freshwater ground pools, both in coastal areas and inland.

Female *Culex salinarius* are inactive during daylight hours but begin flight activity immediately after sunset and continue through the night, terminating activity before sunrise. The peak period of human biting occurs about 45 minutes to 1 hour after sunset (Murphey and Darsie, 1962). They bite man readily and aggressively, often entering houses in search of hosts (Headlee, 1945). In addition to biting man, host preference studies by Crans (1964), Hayes (1961), Murphey et al. (1967) and Wright and Defoliart (1970) have shown that this species is a general feeder on a wide variety of warm-blooded animals. Hayes' study indicated the species would also feed on reptiles and amphibians. The animals found to serve as hosts for this species in these studies included: Birds: mallard duck, canada goose, common egret, barn owl, red-winged blackbird, turkey vulture, domestic chicken, catbird, common grackle, pheasant, domestic pigeon, english sparrow (house sparrow), starling. Mammals: woodchuck, muskrat, raccoon, opossum, red fox, meadow vole, river otter, guinea pig, domestic rabbit, cottontail rabbit, eastern grey squirrel, ground squirrel, eastern chipmunk, white-footed mouse, norway rat, redback vole, little brown bat. Reptiles: northern water snake, eastern box turtle, eastern painted turtle, eastern spotted turtle. Amphibians: bullfrog, green frog.

DISTRIBUTION

Culex salinarius is distributed throughout most of the United States east of the Rocky Mountains, south to Mexico and east to Bermuda (Murphey and Darsie, 1962). This species has been reported as common throughout New York and especially on Long Island by Barnes et al. (1950). The author has collected larvae from several localities throughout the State but never in great abundance except in some freshwater marshes in Suffolk County.

IMPORTANCE

In addition to being a pest species, there is conflicting evidence concerning the role *Cx. salinarius* may play in the transmission of diseases. Eastern encephalitis virus was isolated from two pools of engorged specimens (Burbutis and Jobbins, 1957), but neither Davis (1940) nor Chamberlain et al. (1954) were able to demonstrate transmission of this virus by *Cx. salinarius* in the laboratory. Chamberlain et al. (1958) presumed that the isolations of EE by Burbutis and Jobbins had been from recently ingested blood rather than from mosquito tissues. No isolations of California Group arboviruses were made from over 130,000 specimens of *Cx. salinarius* tested by the CDC Arbovirology Unit from 1962 to 1970 (Sudia et al. 1971). Chamberlain et al. (1954) found this species to be an excellent vector of St. Louis encephalitis virus in the laboratory and considered it to be a possible enzootic vector of this disease. An isolation of SLE from *Cx. salinarius* was reported by Clark et al. (1977).

Experimental transmission of a human filarial worm, *Wuchereria bancrofti* (Eyles and Most, 1947), and bird malarial parasites, *Plasmodium* (Huff, 1927), have also been demonstrated. Other species of the subgenus *Culex* are known to transmit heartworm (*Dirofilaria immitis*) to dogs and other animals (Horsfall, 1962; Intermill and Frederick, 1978), and Seeley and Bickley (1974) have demonstrated that *Cx. salinarius* is a potential vector. This disease has been increasing in the Northeast in recent years and, since *Cx. salinarius* has been shown to be able to transmit *Wuchereria*, it may also be involved in transmission of *Dirofilaria*. Because of its general feeding habits, and its ability to transmit at least some diseases, this species should be considered of importance as a health hazard when it is encountered.

Culex (Culex) tarsalis Coquillett

Culex tarsalis Coquillett, 1896. Can. Entomol. 28:43. Type-loc.: Argus Mountains, California, United States.

Culex willistoni Giles, 1900. Handbook of Gnats or Mosq.: 281. Type-loc.: Argus Mountains, California, United States.

Culex kelloggii Theobald, 1903c. Can. Entomol. 35:211. Type-loc.: Stanford University, California, United States.

DIAGNOSIS

FEMALE — SIZE: Moderate. *HEAD*: Proboscis dark-scaled with wide, median white band; maxillary palpus dark-scaled with white scales at apex of third segment and at tip; occiput with white scales laterally, golden-brown scales behind eyes, white scales and dark, erect scales dorsally. *THORAX*: Mesonotum clothed with golden-brown scales, a pair of pale, submedian half stripes extending from posterior margin to middle of mesonotum, ending in white spots (sometimes separated from half stripes); pleura with small patches of grayish scales. *ABDOMEN*: Most terga dark-scaled with broad, basal bands of white to yellowish-white scales; basal band of second tergite V-shaped; terminal segments sometimes entirely pale-scaled; sternites with V-shaped dark markings. *LEG*: Mostly dark-scaled but with many pale scales on femur and tibia and wide pale bands at base and apex of most tarsal segments. *WING*: Length 4.0-4.5 mm; scales narrow, dark, uniform except for a few white scales on costa and subcosta.

MALE TERMINALIA — Lobes of tergum IX broadly rounded, widely separated, with many long, slender setae. *Tergum X* with a crown of numerous short spines; *basal arm* a long, curved, sclerotized finger-like projection. *Phallosome* consisting of two sclerotized plates joined basally, each with an elongate apical *ventral arm*, a group of several median stout teeth and an elongate basal *dorsal arm* directed posteriorly. *Gonocoxite* about 2.5 times longer than wide; *subapical lobe* undivided, bearing 2 heavy rod-like setae, 3 spine-like setae and a narrow leaf-like filament. *Gonostylus* about 0.5 times length of gonocoxite, curved, with 2 short subapical setae; claw peg-like, apical.

FOURTH INSTAR LARVA — HEAD: Antenna shorter than head, dark at base, light and with many large spicules to seta 1-A, darker, constricted and with small spicules beyond seta; seta 1-A large, multiple, barbed, inserted well beyond middle of antenna shaft; head hairs 5-7 long, multiple, barbed. *ABDOMEN*: Comb with many club-shaped scales in a patch, each clothed with fine spinules. *SIPHON*: Siphon index 4.5-5.5; pecten with 10-15 teeth; 5 long, multiple setae inserted in a straight line beyond pecten. *SEGMENT X*: Saddle complete; seta 1-X usually double or triple (occasionally single), shorter than saddle; dorsal brush a long lower caudal hair and an upper caudal tuft of one long, 2 shorter hairs; anal papillae 1-2 times length of saddle, tapered.

BIONOMICS

Culex tarsalis is a common species west of the Mississippi, where it breeds in all types of aquatic habitats, including ground pools containing emergent vegetation (Dyar and Knab, 1917), artificial containers such as rain barrels, ornamental pools and hoofprints (Rees, 1943). Like *Cx. pipiens*, *Cx. tarsalis* has been collected from both cold, clear, unpolluted water (Seaman, 1945) and from extremely foul water (Hearle, 1926).

Adult females feed primarily on domestic and wild birds, but man and other large mammals are also readily attacked as incidental hosts. Henderson and Senior (1961) also found that they would feed on a number of small mammals, reptiles and amphibians, although the latter were fed on at a much lower rate than mammals, birds or reptiles. They have been described as "painful and usually persistent biters, attacking at dusk and after dark, and readily entering dwellings for blood meals" (Carpenter and LaCasse, 1955).

DISTRIBUTION

Although the normal range of *Cx. tarsalis* is west of the Mississippi, it is occasionally collected in the southeastern states. Larvae have been collected as far north as Cumberland County, Pennsylvania (Thompson, 1970), just south of central New York State, and it is possible that this species could be found in New York as well.

IMPORTANCE

The viruses of California, St. Louis and western encephalitis have been isolated from *Cx. tarsalis* many times, and this species is believed to be a principal vector of both St. Louis and western encephalitis (Bown and Work, 1973; Elbel et al., 1977; Hayes et al., 1976; Smith et al., 1969; Sudia et al., 1971, 1975). Although *Cx. tarsalis* has not been reported from New York, it should be considered of potential importance because it has been collected nearby in Pennsylvania.

Subgenus *Melanoconion* Theobald

Melanoconion Theobald, 1903a. Mon. Cul. 3:238. TYPE SPECIES: *Culex atratus* Theobald, by subsequent designation (Dyar, 1905:49).

Mochlostyrax Dyar and Knab, 1906c. J. N.Y. Entomol. Soc. 14:223. TYPE SPECIES: *Mochlostyrax caudelli* Dyar and Knab, by original designation.

For complete synonymy see Knight and Stone, 1977:251.

IMPORTANT REFERENCES: Belkin et al., 1970:92 (synonymy of *Mochlostyrax*); Sirivanakarn 1982 (1983):265-333 (revised classification of subgenus).

Culex (Melanoconion) erraticus (Dyar and Knab)

Mochlostyrax erraticus Dyar and Knab, 1906c. J. N.Y. Entomol. Soc. 14:224. Type-loc.: Baton Rouge, Louisiana, United States.

For complete synonymy see Knight and Stone, 1977:257.

DIAGNOSIS

FEMALE — SIZE: Small. *HEAD*: Proboscis and maxillary palpus dark-scaled; occiput with narrow, light golden-brown and erect, dark brown scales dorsally, appressed, bronze-brown scales anteriorly, appressed, grayish-white scales laterally. *THORAX*: Mesonotum uniformly clothed with narrow, golden-brown scales; pleura with small patches of grayish-white scales. *ABDOMEN*: Most terga covered with dark brown scales having a metallic appearance, usually with narrow, pale, basal bands; sternites white-scaled basally, dark apically. *LEG*: Mostly dark-scaled with a metallic appearance except for small, pale "knee spot" at apex of tibia. *WING*: Length 2.5-3.0 mm; uniformly dark scaled.

MALE TERMINALIA — Lobes of tergum IX ovoid, narrowly separated, with many long, fine setae. *Tergum X* with an apical comb-like row of spines. *Phallosome* with 2 sclerotized inner plates joined basally, each with stout apical and subapical teeth directed outward, a ventrolateral tooth near base and a ventrally projecting basal hook. *Gonocoxite* about twice as long as wide; *subapical lobe* divided into a basal division having 2 branches, each with a long, strong, rod-like filament and an apical division bearing rod-like filaments and a leaf-like filament. *Gonostylus* more than 0.5 times length of gonocoxite, with a row of very short setae on outer margin near apex and 2 short, subapical, lateral setae; *claw* short, peg-like, subapical.

FOURTH INSTAR LARVA — HEAD: Antenna about length of head, darker and constricted beyond seta 1-A; seta 1-A multiple, barbed, inserted beyond middle of antenna shaft; head hair 5 short, multiple; hair 6 long, single; hair 7 long, multiple. *ABDOMEN*: Comb with many long, thorn-shaped scales in an irregular row. *SIPHON*: Siphon index 6.0-7.0; pecten with 10-20 regularly spaced teeth, followed by 4 or 5 long, multiple setae; 2 small, double or triple subdorsal setae. *SEGMENT X*: Seta 1-X single or double, much shorter than saddle; dorsal brush a long, single lower hair and an upper hair with one short, one long branch; anal papillae varying from 0.5 to 1.5 times as long as saddle, tapered.

BIONOMICS

As reviewed by Horsfall (1955), *Culex erraticus* breeds in permanent pools of water containing emergent vegetation, as well as grassy edges of sluggish streams, impoundments and lake edges. Larvae are most often found associated with *Anopheles quadrimaculatus* and have also been reported to occur with *Uranotaenia sapphirina*, *An. punctipennis*, *Cx. territans*, *Cx. restuans* and other species which breed in clear water having emergent vegetation (Horsfall, 1955; Siverly, 1972).

Inseminated females overwinter in natural shelters, such as hollow trees and caves (Siverly, 1972; Zukel, 1949). Eggs are usually attached in masses to floating leaves or other vegetation, such as duckweed (Dyar, 1922; King et al., 1942). There are normally several generations during the summer.

The preferred hosts of *Cx. erraticus* are birds (King et al., 1942), but man is also fed upon readily, especially outdoors at dusk and dawn (Thibault, 1910; King et al., 1942). Siverly (1972) has also collected *Cx. erraticus* in a trap baited with a frog and a turtle.

DISTRIBUTION

This species is distributed throughout much of southeastern United States as far north as Pennsylvania, Maryland, District of Columbia and Ohio (Darsie and Ward, 1981). It has not been reported from New York but its distribution could extend here.

IMPORTANCE

Culex erraticus is of no known medical importance, but it is sometimes important as a pest species in the southeastern states.

Subgenus *Neoculex* Dyar

Neoculex Dyar, 1905. Proc. Entomol. Soc. Wash. 7:48. TYPE SPECIES: *Culex territans* Walker, by original designation.

IMPORTANT REFERENCES: Linam and Nielson, 1970:149 (taxonomy); Sirivanakarn, 1971:69 (revision).

Culex (Neoculex) territans Walker

Culex territans Walker, 1856. Ins. Saund. Dipt. 1:428. Type-loc.: United States.

Culex saxatilis Grossbeck, 1905. Can. Entomol. 37:360. Type-loc.: Garret Mountain, New Jersey, United States.

Culex frickii Ludlow, 1906. Can. Entomol. 38:132. Type-loc.: Fort Snelling, Minnesota, United States.

Culex pyrenaicus Broelemann, 1919. Ann. Soc. Entomol. Fr. 87:427. Type-loc.: several localities in Pyrenees, France.

Culex nematoides Dyar and Shannon, 1925. Insec. Inscit. Menst. 13:84. Type-loc.: Hagthrope, E. Riding, Yorkshire, England.

Culex apicalis Adams, in part, of Dyar and other authors, not Adams.

DIAGNOSIS

FEMALE — *SIZE*: Small to moderate. *HEAD*: Proboscis and maxillary palpus dark-scaled; occiput with grayish-white to golden-brown, appressed scales dorsally and laterally and with brown, erect scales dorsally. *THORAX*: Mesonotum uniformly clothed with fine scales, usually light golden-brown, grayish-white or dark brown on some specimens, often with a pair of pale, submedian spots near middle. *ABDOMEN*: Most terga dark-scaled with a metallic appearance and with a narrow, apical band of pale scales. *LEG*: Mostly dark-scaled with a metallic appearance except for pale "knee spot" at apex of tibia. *WING*: Length 3.0-3.5 mm; veins uniformly clothed with narrow, brown scales.

MALE TERMINALIA — *Lobes of tergum IX* small, about as long as broad, with several long, fine setae. *Tergum X* with an apical row of short spines. *Phallosome* consisting of a pair of sclerotized plates joined at base and by a narrow bridge about 0.25 times distance from apex; each plate bluntly rounded apically, with many small denticles. *Gonocoxite* about 2.5 times longer than wide; *subapical lobe* undivided, bearing 2 long, heavy, hooked rods and 5 smaller spines. *Gonostylus* about 0.5 times length of gonocoxite, curved, with many small setae, 2 longer setae, and a row of membranous lobes on distal half; claw about 0.20 times length of gonostylus, rod-like.

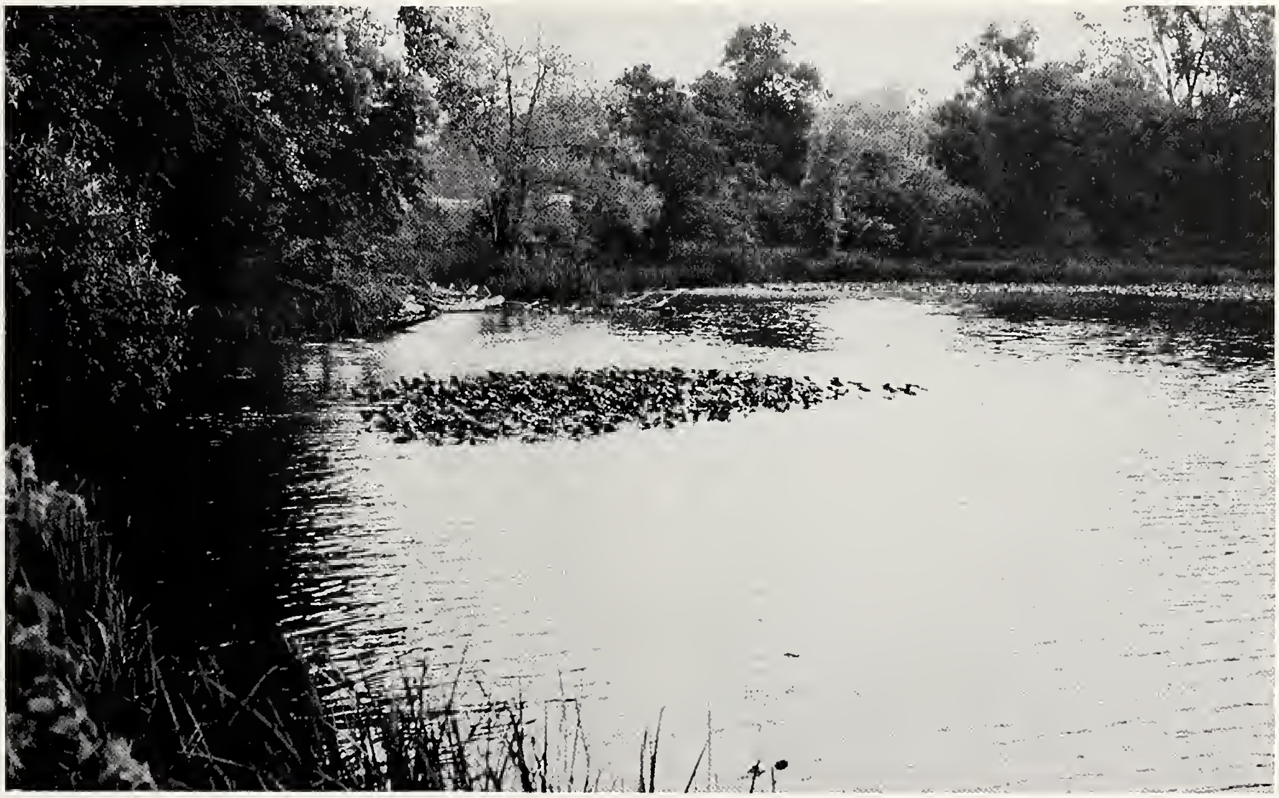


Figure 23. ***Culex territans*** **larvae are often abundant among the grass and weeds surrounding a pond.**

FOURTH INSTAR LARVA – *HEAD*: Antenna about length of head, dark at base, lighter and spiculate to seta 1-A, darker and constricted beyond seta; seta 1-A large, multiple, inserted well beyond middle of antenna shaft; head hairs 5 and 6 long, single (occasionally double or triple), barbed; hair 7 long, multiple. *ABDOMEN*: Comb with numerous club-shaped scales, each clothed with fine spinules or setae. *SIPHON*: Slightly expanded apically; siphon index 5.5-7.0; pecten with 10-20 evenly spaced teeth, followed by 4 or 5 long, multiple setae in a row, except apical seta inserted more laterally. *SEGMENT X*: Saddle complete, dorsoapical corner with numerous short spicules; seta 1-X with 2-4 branches, shorter than saddle; anal papillae usually subequal to length of saddle, tapered.

BIONOMICS

Larvae of *Culex territans* are occasionally collected in muddy water with a rather high organic content (Mullen, 1970), but are usually found in permanent or semi-permanent pools of clear water. They have been reported from a variety of habitats ranging from open sunlit pools to densely shaded and subterranean pools, and from pools with little or no vegetation to ponds crowded with aquatic plants (Barr, 1958; Horsfall, 1955; Rempel, 1953). Larvae of *Cx. territans* also occur along the margins of streams (Gjullin and Eddy, 1972). In New York State this species has been collected from all of these habitats, especially from clear cold water in subterranean pools in sphagnum bogs, open grassy marshes, weedy roadside ditches and weedy pond edges. The author has also found these larvae in clear, sandy-bottom pools containing no apparent vegetation, often located in nearly dry stream beds, and in artificial containers such as boats, discarded tires, buckets, barrels and cemetery vases. Although larvae are frequently found in open sunlit pools, they usually congregate under or near a shaded portion, such as under an overhanging branch, a board, a log or a clump of grass. Larvae of *Cx. territans* can often be distinguished from other larvae in the field because the body is normally held parallel to the water surface, whereas the bodies of the other culicine species usually hang downward at an angle to the surface (Knab, 1904).

Larvae of *Cx. territans* are usually the earliest of the *Culex* species to appear in the spring. First instar larvae can be found in New York State by late April at lower elevations and about one week later in the mountainous areas. Fourth instar larvae are present throughout most of the State by early June. Although Ross (1947) indicated reproduction might decrease during the summer in Illinois, breeding is apparently continuous throughout the summer in New York, as reported for Massachusetts (Knab, 1904). Larval abundance increases, especially in cooler, shaded pools, through mid-July, then tends to remain stable through late August, followed by a gradual decline until frost.

In New York, larvae of *Cx. territans* are most commonly found associated with *Cx. restuans*, *Culiseta melanura*, *Cs. morsitans*, *Anopheles punctipennis*, *An. walkeri*, *An. quadrimaculatus*, *Aedes vexans*, *Ae. cinereus*, *Ae. triseriatus* and *Uranotaenia sapphirina*. Mullen (1970) also found them associated with *Coquillettidia perturbans* and *Aedes canadensis*. Elsewhere, and occasionally in New York, they have been collected with *Aedes punctor*, *Ae. sollicitans*, *Ae. taeniorhynchus*, *Ae. cantator*, *Culex pipiens*, *Cx. salinarius*, *Culiseta inornata*, *Anopheles bradleyi*, *Psorophora* spp. and *Orthopodomyia signifera* (Horsfall, 1955).

In late fall, mated females which have fed on carbohydrates but not on blood, hibernate in protected places, usually subterranean enclosures which maintain relatively stable temperature and humidity throughout the winter (Berg and Lang, 1948). These authors observed that the overwintering *Cx. territans* moved about within the hibernation site during the winter and that they were easily disturbed by light. Upon emerging from hibernation females obtain a blood meal before depositing an egg raft. Overwintered females have been observed feeding on a frog as early as April 26 in Ontario (Burgess and Hammond, 1961). Egg rafts have been collected on Long Island as early as May 5, and first instar larvae as early as May 7. Knab (1904) has described in detail the eggs of *territans* which are laid in rafts on the banks of a breeding place or the sides of a container, rather than on the water surface, as are the rafts of other species of *Culex*. The rafts are washed onto the water surface by rain or by fluctuating water levels and do not hatch until they are on the water surface. The author has also observed *Cx. territans* females depositing egg rafts on the sides of a container partially filled with water, as described by Knab. The rafts were attached about a half to one inch above the water level, and when sprayed with a fine mist the following day they were easily washed off the container wall and onto the water surface.

Although female *Cx. territans* have occasionally been reported to feed on warm-blooded animals, including rodents, raccoon, birds (Crans, 1964), man (Means, 1965; West and Hudson, 1960), as well as beef blood (Edman and Downe, 1964), they feed primarily on cold-blooded vertebrates (Barr, 1958; Carpenter and LaCasse, 1955; Dyar, 1928; Matheson, 1944; Means, 1968). Among the cold-blooded hosts reported for this species are: American toad, bullfrog, northern leopard frog, western chorus frog, blacksnake, eastern garter snake, kingsnake, northern water snake, eastern box turtle, and snapping turtle (Burgess and Hammond, 1961; Means, 1968; Murphey et al., 1967; Shannon, 1915; Wright and DeFoliart, 1970).

DISTRIBUTION

Culex territans occurs in eastern Europe, western USSR, Turkey, northern Africa, Canada, Alaska and throughout most of the continental United States (Bohart, 1948; Knight and Stone, 1977). It is common throughout New York State, especially in places where cool, clear water is available for breeding.

IMPORTANCE

Although mice have been infected experimentally with the bacteria of tularemia by ingestion of infected *Cx. territans* (Bozhenko, 1937), there is at present no evidence that this species is a vector of disease organisms to man or to domestic animals. Since it is rarely attracted to man or other warm-blooded animals it is considered to be of no medical importance.

Tribe Culisetini

Genus *Culiseta* Felt

Theobaldia Neveu-Lemaire, 1902a. C.R. Soc. Biol., Paris 54:1331 (*non* Fischer, 1885). TYPE SPECIES: *Culex annalatus*. Schrank, by original designation.

Culiseta Felt, 1904. Bull. N.Y. St. Mus. no. 79:391c. TYPE SPECIES: *Culex absorbrinus* Felt, by original designation.

The genus *Culiseta* contains seven subgenera with 42 species and subspecies listed by Knight (1978), Knight and Stone (1977) and Ward (1984). Three subgenera, *Climacura*, *Culicella* and *Culiseta* are represented in New York by five species and subspecies.

This genus was originally described and given the name *Theobaldia* by Neveu-Lemaire (1902a). However, since *Theobaldia* was preoccupied by a genus of mollusk described by Fischer (1885), the next available name, *Culiseta* Felt (1904), was assigned to this mosquito genus. The genus *Culicella*, also described by Felt in 1904, has been designated a subgenus of *Culiseta*.

DIAGNOSIS

ADULT (figs. 153-166) — *HEAD*: Proboscis and maxillary palpus dark-scaled, with scattered pale scales present in some species; proboscis of female longer than antenna and fore tibia; maxillary palpus of female about 0.25 length of proboscis, of male usually as long as proboscis; antenna of female with sparse whorls of setae, segments subequal; antenna of male densely plumose, shorter than proboscis; occiput with narrow, curved or lanceolate scales and dark, erect, forked scales dorsally, broad, appressed scales laterally; integument of torus brown or black, with or without scales on inner surface. *THORAX*: Integument of mesonotum brown or black, scale pattern and colors variable; pleura usually with patches of dingy-white or cream-colored scales; prespiracular setae present; postspiracular setae absent. *ABDOMEN*: Terga of most segments dark-scaled with basolateral patches or with basal and sometimes apical bands of pale scales; tip of abdomen bluntly rounded, eighth segment not retractile. *LEG*: Femur and tibia primarily dark-scaled, often with pale scales intermixed; femur sometimes pale-scaled on posterior surface, tibia often with pale "knee spots" at apex; tarsi either entirely dark or with basal and sometimes apical bands of pale scales; pulvilli absent. *WING*: Most scales narrow, dark, sometimes clumped in dense patches forming dark spots on some veins; subcosta with dense patch of setae at base on underside; alula fringed.

MALE TERMINALIA (figs. 162-166) — *Tergum X* with a few teeth at apex. *Phallosome* divided in most species. *Claspettes* absent. *Gonocoxite* at least twice as long as mid-width, *basal lobe* present and variable, *apicodorsal lobe* small or absent. *Gonostylus* simple, about 0.66 times length of gonocoxite; *claw* inserted at apex of gonostylus.

FOURTH INSTAR LARVA (figs. 144-152) — *HEAD*: Wider than long; antenna variable, from less than 0.5 times length of head to longer than head; seta 1-A multiple, position and branching variable; length, branching and position of head hairs 5, 6 and 7 variable with species. *THORAX*: Prothoracic hairs 1 and 2 long, 1- 5-branched, hair 3 of medium length, 3- 6-branched. *ABDOMEN*: Comb of eighth segment of most species with many scales in a patch, each scale club-shaped and clothed with fine subequal spinules. *SIPHON*: Siphon index 2.5-7.0; pecten variable, in some species with teeth followed by even row of long setae or with ventral row of multiple setae; seta 1-S inserted within pecten, near base of siphon, large and multiple in most species. *SEGMENT X*: Saddle complete; seta 1-A usually at least length of saddle; anal papillae variable, pointed.

KEY TO SPECIES OF THE GENUS *CULISETA*

FOURTH INSTAR LARVAE

1. Siphon with median ventral row of 8-16 multiple setae (fig. 151). . . . .(*Climacura*) *melanura*
   Siphon without median ventral row of setae 2
2. Distal pecten teeth hair-like (fig. 149). . . . .(*Culiseta*) 3
   Distal pecten teeth not hair-like. . . . .(*Culicella*) 4
3. Seta 1-X stout, as long as or longer than saddle (fig. 149) . . . .*inornata*
   Seta 1-X fine, shorter than saddle (fig. 152) . . . . .impatiens
4. Head hair 5 usually with 7 or more branches; head hair 7 usually with 9 or more branches (fig. 144); ventral brush of segment X usually with 18 or fewer tufts (fig. 150) . . . .*minnesotae*
   Head hair 5 usually with 6 or fewer branches; head hair 7 usually with 8 or fewer branches (fig. 148); ventral brush usually with 20 or more tufts . . . . *morsitans*

FEMALES

1. Hindtarsi with pale rings on some segments (sometimes very narrow) (fig. 153) . . .(*Culicella*) 2
   Hindtarsi entirely dark-scaled (fig. 154) 3
2. Abdominal terga with pale bands at both base and apex (fig. 155) . . . .*minnesotae*
   Abdominal terga with pale bands at base only (fig. 156) . . . .*morsitans*
3. Costa with mixed dark and pale scales (fig. 158). . . . .(*Culiseta*, pars) *inornata*
   Costa with dark scales only 4
4. Crossvein r-m and vein M_{3+4} separated on vein M by a distance equal to or greater than length of either vein; small species (wing length less than 4 mm) (fig. 159). . . . . (*Climacura*) *melanura*
   Crossvein r-m and vein M_{3+4} separated by less than length of either vein; large species (wing length more than 5 mm) (fig. 160) . . . . (*Culiseta*, pars) *impatiens*

MALE TERMINALIA

1. Apicodorsal lobe present (fig. 162) . . . .(*Culiseta*, pars)*impatiens*
   Apicodorsal lobe absent or faintly indicated 2
2. Phallosome consisting of a pair of long, dark sclerotized rods, each having a small membranous piece apically (fig. 166) . .(*Culiseta*, pars) *inornata*
   Phallosome wide and bulbous, only slightly sclerotized. . . . .
3. Phallosome somewhat quadrate, its lateral margins angulate near apex (fig. 164) . . . .(*Culicella*, pars) *minnesotae*
   Phallosome ovate, lateral margins sinuate or rounded. 4
4. Phallosome enlarged basally and apically, constricted medially, the basal and apical enlargements subequal (fig. 163); large species . . . .(*Culicella*, pars) *morsitans*
   Phallosome broadly ovate, broader apically than basally (fig. 165); small species . . . . (*Climacura*) *melanura*

Subgenus *Climacura* Howard, Dyar and Knab

Culex, subgenus *Climacura* Howard, Dyar and Knab, 1915. Carnegie Inst. Wash. Publ. No. 159(3):452. TYPE SPECIES: *Culex melanurus* Coquillett, by original designation.

Culiseta (Climacura) melanura (Coquillett)

Culex melanura Coquillett, 1902. J. N.Y. Entomol. Soc. 10:193. Type-loc.: Center Harbor, New Hampshire, United States.

DIAGNOSIS

FEMALE — *SIZE*: Small. *HEAD*: Proboscis and maxillary palpus dark-scaled; occiput with narrow, flat, yellowish-white scales and erect, dark scales dorsally, a patch of broad, pale scales laterally; torus brown. *THORAX*: Mesonotum clothed with fine, bronze-brown scales, golden-brown in prescutellar space; scutellum with golden-brown scales and dark brown setae; pleura with patches of pale whitish scales. *ABDOMEN*: Terga clothed with bronze-brown scales having a purplish cast; small patches of pale yellowish-white scales on sides of some segments at base; narrow basal bands of pale scales sometimes present on some segments; sternites mostly pale-scaled. *LEG*: Dark-scaled except for pale-scaled posterior surface of femor. *WING*: Length 3.03.8 mm; longitudinal veins with dark scales; crossvein r-m and vein M_{3+4} separated on media by more than length of either vein.

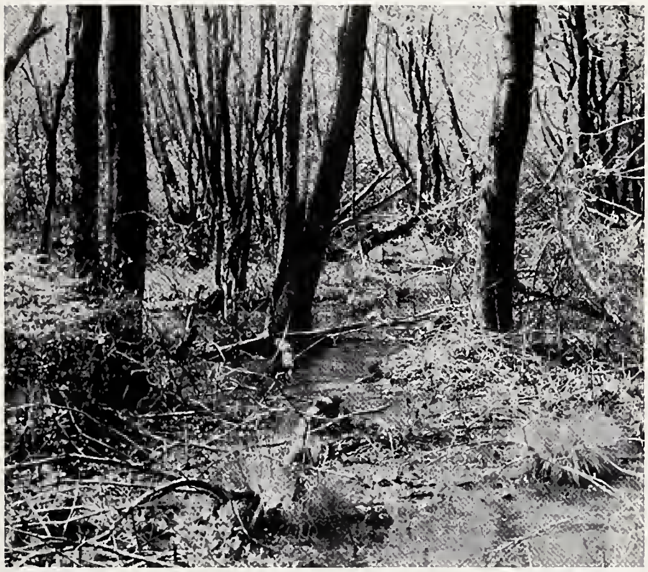
MALE TERMINALIA — Lobes of tergum IX with several long setae. *Tergum X* heavily sclerotized and with 2-3 heavy, curved teeth apically. *Phallosome* cylindrical, rounded apically, open ventrally and on basal half dorsally, closed dorsally beyond middle. *Gonocoxite* about 2.5 times longer than wide, with long setae on outer aspect, shorter setae medially; *basal mesal lobe* prominent, conical, with few long, heavy spines at apex and many shorter spines subapically. *Gonostylus* with few or no spicules, claw short, bifucate.

FOURTH INSTAR LARVA — HEAD: Antenna about as long as head, spiculate; seta 1-A large, multiple, inserted in distal 0.25 of antenna shaft, extending beyond tip, hear hair 5 multiple, smooth; hair 6 single, barbed, about twice length of hair 5; hair 7 multiple, barbed, about length of hair 5. *THORAX*: Prothoracic hairs 1 and 2 single, very long; hair 3 double or triple, shorter than 1 or 2. *ABDOMEN*: Comb composed of about 25 long slender scales in a single row, each scale pointed basally, rounded and fringed with small spinules apically. *SIPHON*: Siphon index 6.0-7.0; pecten composed of numerous teeth on basal 0.33 of siphon, distal 1 to 3 teeth usually somewhat detached from the rest; seta 1-S small, 2- 3-branched, inserted within pecten near base of siphon; a median ventral row of about 10-16 short multiple setae; 5 or 6 very small 2- 3-branched dorsolateral setae. *SEGMENT X*: Seta 1-X about length of saddle, single or double; dorsal brush consisting of a lower caudal tuft of 1 long and 2 short hairs, an upper caudal tuft of 4-8 subequal hairs; anal papillae about length of saddle, pointed.

BIONOMICS

Culiseta melanura exhibits the typical type of life cycle described by Pratt (1959), in which larvae overwinter in various stages of development, eggs are deposted on the water surface and there are several generations per year. Eggs are laid in rafts or boats on the water surface (Chamberlain et al., 1955; Wallis, 1954a,b) from late June to September, with the greatest number being found in August on Long Island, and in late July in the mountainous regions of New York State.

Smith (1904), in referring to the notes of Mr. J. Turner Brakeley, an experienced and dedicated field observer, stated that larvae had been collected during the winter months from holes that had been frozen over. Smith says of Brakeley and his determination, "It was Mr. Brakeley, also, who demonstrated that *Culex melanurus* passed the winter in the larval stage, and in that investigation he tramped the bogs in sleet and rain storms in midwinter, and collected in ice-cold water until he was drenched and his fingers so benumbed with cold that he could no longer handle the collecting materials. But he persisted until his facts were established beyond peradventure,." Burbutis and Lake (1956) reported that larvae, mostly fourth instars, can be found in New Jersey throughout the winter, and Siverly and Schoof (1962) collected second to late fourth instar larvae from a bog in Indiana in early April. The author has collected second, third and fourth instar larvae in December from water which had earlier been covered with a 1-inch thick layer of ice, and also from water with a similar ice layer under 15 inches of snow in



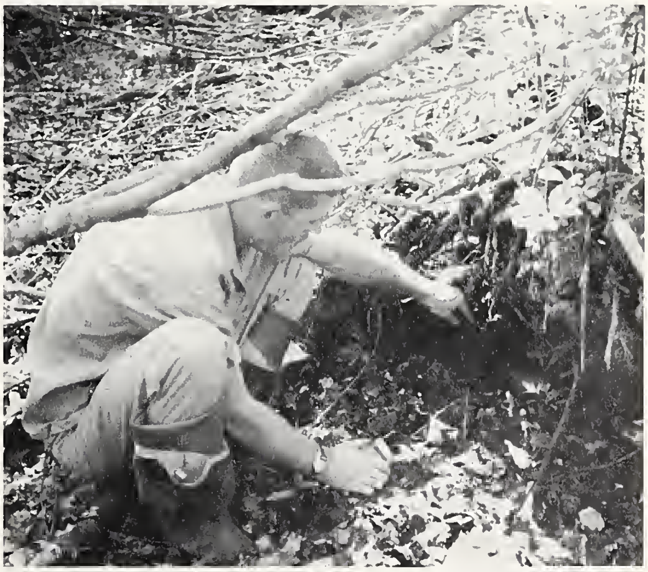


Figure 24. ***Culiseta melanura, Cs. morsitans*** **and** ***Culex territans*** **are commonly found in cold-water bogs: a. cool-water pools in a wooded bog. b. Collecting** ***Culiseta melanura*** **larvae from a pool formed by an uprooted tree in a bog.**

March. Burbutis and Lake (1956) collected adults in New Jersey as early as late May, indicating pupation must have occurred by mid-May. On Long Island, pupae have been collected as early as May 10 and adults by May 25. These data support the investigations reported by Smith in 1904 that the species overwinters in the larval stage in the northern parts of its range.

The immature stages of *Cs. melanura* are found in habitats which are dark (or at least well shaded), are in contact with soil, and contain cold water (Burbutis and Lake, 1956; Siverly and Schoof, 1962). Burbutis and Lake found larvae in New Jersey most often in well shaded woodland springs in sphagnum bogs, whereas in Georgia, Siverly and Schoof reported finding larvae and pupae in tree rot cavities, soil pockets lined with roots and similar habitats. In New York, immatures of this species are most often collected from holes beneath mats of sphagnum and from cavities around the roots of trees in woodland bogs. In sphagnum bogs, large subsurface cavities often have small external openings through which larvae may be collected. Other mosquito species with which larvae of *Cs. melanura* are most commonly found associated in New York are *Cs. morsitans* and *Culex territans*.

Females of *Culiseta melanura* feed primarily on birds and to some extent on reptiles and amphibians, but only rarely on mammals. In addition to rare records of its being attracted to or biting man (Feemster and Getting, 1941; Hayes and Doane, 1958; Moussa et al., 1966; Schober, 1964; Stabler, 1948), the known hosts include: Mammals: swine, deer, raccoon, cow, dog, horse, eastern chipmunk, "domestic rabbit," eastern cottontail, New England cottontail, Norway rat, eastern gray squirrel, redbacked vole, opposum; Birds: chicken, "common grackle," ring-necked pheasant, "domestic pigeon," English sparrow, starling, bobwhite quail, catbird, bluejay, mallard, white Pekin duck, rufous-sided towhee, robin, ruffed grouse; Reptiles: eastern milk snake, northern snake, eastern garter snake, eastern box turtle; Amphibians: northern leopard frog (Bennett and Fallis, 1960; Crans, 1964; Hayes, 1961; Jobbins et al., 1961; Means, 1968; Moussa et al., 1966; Schober, 1964; Schober and Collins, 1966). *Culiseta melanura* females are most active during early morning and early evening hours and rest during the day in cool, humid, dark enclosures, such as caves, hollow trees, exposed tree roots, cisterns and culverts. Because they are not attracted to light, and seek dark, protected places during the day, artificial resting sites have been used for collecting them. Burbutis and Jobbins (1957) used an open box (2 ft. x 1 ft. x 1 ft.) lined with black cloth to simulate a natural resting site. In experiments on Long Island, the author found that 1-foot wooden cubes, open on one end, painted flat black on the outside, dark red on the inside, were most effective in attracting adult *Cs. melanura* for resting. The boxes were placed on their sides in bog areas known to contain breeding sites, and resting mosquitoes were removed by means of a mouth aspirator.

DISTRIBUTION

Culiseta melanura is distributed throughout the eastern and central United States, to Colorado and Texas. In New York State the species is most commonly found in fresh water swamps and sphagnum bogs on Long Island, (Jamnback, 1961; W. G. McClure, pers. comm.), and has also been collected in moderate abundance from bogs throughout the State.

IMPORTANCE

Culiseta melanura has long been considered a primary enzootic vector of Eastern encephalitis, maintaining the virus in wild birds (Hayes, 1961; Hayes et al., 1962). It has also been incriminated as an epizootic vector among wild and domestic birds such as ducklings and pheasants (Burbutis and Jobbins, 1957; Chamberlain, 1960; King et al., 1960). The viruses of western encephalitis, California encephalitis and Flanders virus have also been isolated from this species (Schober and Collins, 1966; Taylor et al., 1966; Whitney, 1964).

Although *Cs. melanura* prefers birds as hosts, it occasionally feeds on man and other mammals (Moussa et al., 1966; Schober, 1964; Schober and Collins, 1966). In addition to being considered an important species in New York because of its role as an enzootic and epizootic vector of EE and other arboviruses to bird populations, *Culiseta melanura* is also an important potential vector or abroviruses to man or other mammals as incidental hosts, especially at times when there are high infection rates in the bird populations.

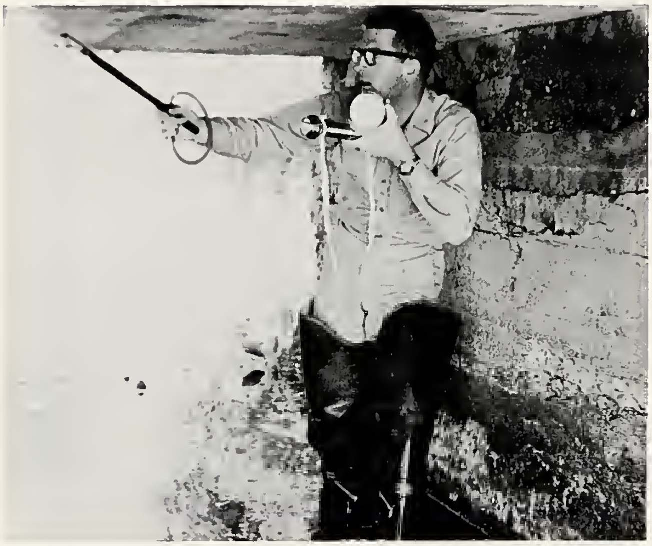


Figure 25. Collecting *Culiseta melanura* females resting on the walls and ceiling of a culvert on Long Island.

Subgenus *Culicella* Felt

Culicella Felt, 1904. Bull. N.Y. State Mus. 179:391c. TYPE SPECIES: *Culex dyari* Coquillett (*Culiseta morsitans dyari* Theobald), by original designation.

Culiseta (Culicella) morsitans (Theobald)

Culex morsitans Theobald, 1901a. Mon. Cul. 1:8. Type-loc.: England.

Culex dyari Coquillett, 1902. J. N.Y. Entomol. Soc. 10:192. Type-loc.: Center Harbor, New Hampshire, United States.

Culex brittoni Felt, 1905. Entomol. News 16:79. Type-loc.: Branford, Connecticut, United States.

Culicella parodites Dyar, 1928. Carnegie Inst. Wash. Publ. 387:244. Type-loc.: Saxeville, Wisconsin, United States.

IMPORTANT REFERENCES: Maslov, 1964:103, 154 (Synonymy); Wood et al., 1979:309, 312 (Synonymy).

DIAGNOSIS

FEMALE — SIZE: Medium. *HEAD*: Proboscis and maxillary palpus dark-scaled; occiput with narrow, yellowish-white, appressed scales and dark, erect scales dorsally; broad, yellowishwhite scales laterally. *THORAX*: Mesonotum brown, clothed with fine golden-brown scales, with white scales in a narrow median line, along anterior and lateral edges, around prescutellar area and in two posterior half-stripes; scutellum with white scales and dark setae; pleura with patches of grayishwhite scales. *ABDOMEN*: Most terga brown-scaled with narrow, basal bands of yellowish-white scales. *LEG*: Dark-scaled except for posterior surface of femur and tibia, pale "knee spot" at apex of tibia and faint pale rings at both ends of some tarsal segments, less distinct or absent on distal segments. *WING*: Length 5.0-5.5 mm; crossvein r-m and vein M_{3+4} separated on media by more than length of either vein; scales narrow, dark brown.

MALE — HEAD: Maxillary palpus long, ventral brushes from apex of segment 2 to tip. *TERMINALIA*: *Tergum VIII* with 8-10 long spines on lobes of apical margin. *Lobes of tergum IX* with many long setae. *Tergum X* sclerotized and with 2-3 teeth apically. *Phallosome* cylindrical, apical third tapering to a point. Open in center ventrally, open dorsally on basal half. *Gonocoxite* about 2.5 times longer than wide, with long setae on outer aspect, shorter setae medially; basal mesal lobe prominent, conical with 3-5 heavy spines and several smaller setae; apicodorsal lobe absent; *Gonostylus* smooth except for few small setae; claw short, bifurcate.

FOURTH INSTAR LARVA — HEAD: Antenna curved, spiculate, about as long as head; seta 1-A large, multiple, inserted beyond middle of antenna shaft and reaching beyond tip; head hair 5 usually with 3-7 branches, hair 7 usually 5- 9-branched, hair 6 usually double, much longer than 5 or 7. *THORAX*: Prothoracic hairs 1 and 2 very long, single; hair 3 long, usually double. *ABDOMEN:* Comb composed of many scales (50-100 or more) in a patch, each scale club-shaped, clothed with many fine spinules. *SIPHON:* Siphon index 6.0-7.0; pecten composed of 8-12 teeth at base of siphon, with distal one or more teeth detached; seta 1-S large, multiple, inserted within pecten near base of siphon. *SEGMENT X:* Longer than wide; dorsal brush with a lower tuft of three long unequal branches and an upper tuft of many branches; ventral brush with 20-22 tufts; anal papillae about length of saddle, pointed.

BIONOMICS

Culiseta morsitans is classified by Pratt (1959) as having the northern *Aedes* type of life cycle, in which eggs are deposited on damp earth or mud, where they overwinter, and in which there is a single generation per year (univoltine). Most other *Culiseta* species lay their eggs on the water surface, overwinter in the larval or adult stage, and are multivoltine. Pratt's classification was based on observations made on the European form, formerly known as *Cs. morsitans morsitans*. This exhibits some biological differences from the American form of *Cs. morsitans* (Maslov, 1964; Wallis and Whitman, 1968), but investigations by Wallis (1957) and by Wallis and Whitman (1968) confirmed that the American population exhibits the same type of life cycle.

The immature stages of *Cs. morsitans* are usually found in temporary cold-water pools, both in shaded forests and in open marshes. Matheson (1944) found them only in holes under old tree stumps. According to Owen (1937) and Irwin (1942) the most common habitats in the northern United States are acid tamarack bogs and cold forest pools. The author has most often collected *Cs. morsitans* larvae in large, shallow, woodland marshes close to the roots and trunks of trees, and in pools up to 2 or 3 feet deep formed by large, uprooted trees, but also in open cattail marshes, especially congregated around tree stumps and dense clusters of emergent vegetation. Wallis and Whitman reported that larvae of this species are normally found only in the spring, supporting earlier observations that this species is univoltine both in Europe and North America (Horsfall, 1955; Howard, et al., 1915; Matheson, 1944). First instar larvae have been collected in New York as early as mid-March and fourth instar larvae and pupae as early as mid-May. A few isolated fourth instar larvae have been collected as late as July 28 in the Adirondacks, probably the result of late-hatching eggs. In New York State the larvae of *Cs. morsitans* are commonly associated with larvae of *Cs. melanura, Aedes excrucians, Ae. fitchii. Ae. abserratus, Ae. cinereus, Ae. punctor, Ae. canadensis, Anopheles punctipennis* and *Culex territans.* In addition to these species Mullen (1970), also found them associated with *An. walkeri* and *Ae. stimulans* in Tompkins County. Owen (1937) included *Ae. diantaeus, Ae. sticticus* and *Cs. inornata* as common associates of *Cs. morsitans* in Minnesota.

Adult emergence usually begins about late May and continues through June and early July, followed by a peak of blood-feeding from mid-July to mid-August (Wallis, 1957). The incidence of females containing fresh blood declines after mid-August with a corresponding increase in the number of gravid females (Wallis and Whitman, 1968). Females of *Cs. morsitans* begin depositing egg rafts containing about 150-250 eggs in early September. Unlike other species of *Culiseta* which deposit their eggs on the water surface, *Cs. morsitans* females attach their eggs to a moist substrate about 1.5 to 2 inches above the water level in suitable habitats (Wallis and Whitman, 1968). These authors found that females which did not deposit eggs exhibited poor capacity for survival, thereby concluding that eggs, rather than larval or adult stages, overwinter as in most species of *Culiseta.*

DISTRIBUTION

Culiseta morsitans is distributed across northern North America from New Jersey, Delaware, Kentucky, Illinois, South Dakota and Colorado north to Alaska, Yukon Territory and Newfoundland (Barr, 1958; R. Lake, pers. comm.); also Eurasia and North Africa (Wood et al., 1979). In New York State it is the most common species of *Culiseta,* and can be found, though not usually in great abundance, in cool forest pools and bogs throughout the State.

IMPORTANCE

Little is known regarding the hosts of female *Culiseta morsitans.* Hayes (1961) found this species to be more attracted to birds than to mammals or cold-blooded animals. Since this species is apparently non-homophilic and has not been incriminated in the transmission of diseases among animals it is considered of no medical or economic importance.

Culiseta (Culicella) minnesotae Barr

Culiseta minnesotae Barr, 1957b. Proc. Entomol. Soc. Wash. 59:163. Type-loc.: Olcott Park, City of Virginia, St. Louis County, Minnesota, United States.

IMPORTANT REFERENCES: Maslov, 1964:103 (to subspecific status); Wood et al., 1979:306, 309 (return to specific status).

The male and female of *Culiseta minnesotae* were described from Minnesota by Barr in 1957, and the larva and pupa by Price in 1958. The species was later reported by Maslov (1964), in his revision of *Culiseta,* as a morphologically and geographically distinct subspecies of the Old World species, *Cs. silvestris* Shingarev. In 1979, Wood et al., restored *Cs. minnesotae* to specific status.

DIAGNOSIS

FEMALE — SIZE: Medium. *HEAD*: Proboscis dark scaled with scattered pale scales medially and ventrally; maxillary palpus dark scaled; occiput with narrow, silvery, appressed scales and dark, erect scales; torus light brown with small dorsal patch of dark brown scales. *THORAX*: Mesonotum integument with two broad, light brown stripes separated by a narrow, median dark brown line, clothed laterally with small, coppery brown scales; with silvery scales in 2 half stripes and in a patch covering much of the posterior quarter, and 2 small patches of silvery scales at approximately the middle, lateral to the light brown stripes; scutellum with silvery-white scales and long, dark bristles; prespiracular setae yellowish; pleura with patches of pale scales; mesepimeron with both upper and lower mesepimeral setae. *ABDOMEN*: Terga with brown scales medially, both basal and apical margins with bands of pale, dingy, yellowish scales; tergite of eighth segment almost entirely pale scaled; sternites mostly pale scaled. *LEG*: Legs largely dark scaled, with pale scales intermingled, with white "knee spots" on femur and with basal and apical white rings on some tarsal segments. *WING*: Length 5.0-5.5 mm; veins with narrow brownish scales.

MALE TERMINALIA — Nearly identical to *Cs. morsitans* except that phallosome is subquadrate and sclerotized at apex.

FOURTH INSTAR LARVA — HEAD: Wider than long; antenna length of head, curved, seta 1-A multiple, inserted at constriction, near distal 0.33 of antenna shaft; hairs 5 and 7 large, multiple, barbed, hair 5 usually 7- 8-branched; hair 7 usually 9- 12-branched; hair 6 double or triple, barbed; about twice length of hair 5. *THORAX*: Prothoracic hairs 1 and 2 simple, 3 and 4 double, 5 and 6 simple, all long, subequal. *ABDOMEN*: Lateral hair 6 multiple on segments I and II; long, single on segments III-VI; comb consisting of many scales (50-100 or more) in a patch, each scale enlarged distally and clothed with subequal spinules. *SIPHON*: Siphon index 6.0-7.0; pecten consisting of 6-14 teeth with the distal 3-5 teeth more widely spaced; seta 1-S with 3-7 branches, inserted within pecten near base of siphon. *SEGMENT X*: Longer than wide; seta 1-X single (occasionally double), slightly longer than saddle; dorsal brush with upper caudal tuft multiple (10-16 branches), lower caudal tuft 2-4 branched; ventral brush with 16-19 tufts, 5-7 of which are precratal; anal papillae approximately length of saddle, pointed.

BIONOMICS

The biology of *Culiseta minnesotae* is not well known, and since it has been reported only rarely from New York little information on its life cycle in this area is available. Most of the following has been summarized from a study by Price (1961) on the biologies of this species and of *Cs. morsitans* in Minnesota.

Main et al. (1968) classified this species as having the "*Culiseta impatiens*" type of life cycle with a single generation per year (Pratt, 1959) in Massachusetts. Price, however (1961) reported that it was multivoltine with several continuous generations during the summer in Minnesota ("*Culex pipiens*" type of life cycle). Fertilized females which have overwintered have been collected as early as the first week of May in Minnesota (Barr, 1957b; Price, 1961). Eggs are probably deposited in irregular rafts on the water surface as are the eggs of most *Culiseta* species.

Larvae begin to appear in Minnesota in late May, at approximately the same time *Cs. morsitans* is in the late larval or pupal stage; and about the time when larvae of other multivoltine species begin to appear. In Connecticut, Mallia (1964) did not find larvae before July 9. The only larvae of *Cs. minnesotae* reported from New York were collected in Suffolk County in late May and in Schuyler County in mid-June (Means and Thompson, 1971). Larvae are found in exposed, semi-permanent or permanent marshes, especially those containing sedges and cattails, where they tend to stay adjacent to emergent vegetation. They are easily overlooked during routine larval collecting unless special care is taken to dip water from the center and edges of this emergent vegetation. The larval stage of *Cs. minnesotae* is probably completed more quickly, due to warmer water later in the season, than that of *cs. morsitans*, which requires 4-6 weeks. Larvae of this species are commonly associated in Minnesota with the same developmental stages of *Culex territans*, *Culiseta inornata*, *Anopheles earlei*, *An. punctipennis* and *An. walkeri*. Specimens of univoltine *Aedes* species, including *Ae. euedes* (as *barri*), *Ae. cinereus*, *Ae. excrucians* and *Ae. fitchii* are also found associated with *Cs. minnesotae*, but further along in their development (Price, 1961).

The few specimens of *Cs. minnesotae* collected in New York State have been taken in light traps or as larvae. Mallia (1964) and Graham (1969) both found this species to be unattracted to man. Graham also reported it was not readily attracted to light, but was more easily collected in Malaise traps. Because of the difficulty in collecting adult females by the usual methods of light trapping and collections of biting specimens, it is possible that *Cs. minnesotae* is more prevalent than collection records indicate. Hayes (1961) found that this species was attracted to and fed on a variety of small mammals and birds and that it preferred warm-blooded to cold-blooded animals, but, except for these observations, the hosts are unknown.

DISTRIBUTION

Culiseta minnesotae is distributed throughout most of the northern United States and southern Canada. In New York State it has been reported from scattered localities in Suffolk, Schuyler, Orange, Jefferson, Ulster and Orleans Counties (J. Kokas, pers. comm.; Means and Thompson, 1971). It is probably more widely distributed, both in New York State and in other states and Canada, than present collection records indicate, but specific methods must be employed to collect both larvae and adults. It is also likely that some specimens in collections labelled as *Cs. morsitans* may actually be *Cs. minnesotae*.

IMPORTANCE

There is no evidence that this species serves as a vector of any diseases of man or animals. Because it is not attracted to man and is rare in New York State and uncommon throughout most of its range, it is not considered of any medical or economic importance.

Subgenus *Culiseta* Felt

Theobaldia Neveu-Lemaire 1902a, C.R. Soc. Biol., Paris 54:1331 (*non* Fischer, 1885). TYPE SPECIES: *Culex annulatus* Schrank, by original designation.

Culiseta Felt 1904, Bull. N.Y. State Mus. 79:391c. TYPE SPECIES: *Culex absobrinus* Felt, by original designation.

Theobaldinella Blanchard 1905, Les Moustiques: 390. TYPE SPECIES: *Culex annulatus* Schrank (type automatically fixed for replacement name).

Pseudotheobaldia Theobald 1907, Mon. Cul. 4:271. TYPE SPECIES: *Pseudotheobaldia niveitaeniata* Theobald, by monotypy.

Culiseta (*Culiseta*) *annulata* Schrank

Culex annulata Schrank, 1776. Beytr. zur Natur: 97. Type-loc.: Linz, (Ober-Oesterreich), Austria.

For additional information regarding synonymy see Knight and Stone (1977:280) and Faran and Bailey (1980:284).

A single female of *Culiseta annulata* was collected from Manorville, Suffolk County, New York by the Suffolk County Bureau of Vector Control in 1983 (Guirgis, 1984).

Culiseta annulata is distributed throughout western and central Europe, Scandinavia, part of USSR, Middle Asia, the Mediterranean and North Africa. A female was collected from an airplane arriving in New York from Stockholm (Faran and Bailey, 1980). Larvae of *Cs. annulata* are found in ditches, stagnant pools, puddles, marshes, barrels and concrete reservoirs. The species is known to breed in fresh and brackish water, and has been collected in large numbers from manure water. Faran and Bailey have described characteristics to differentiate this species from *Cs. particeps*, a western North American species. These species may be separated from *Cs. morsitans* by the wide pale bands on the hindtarsi, that of segment 2 covering 0.25 to 0.33 of the segment, compared to 0.10 of the segment on *Cs. morsitans*.

Because there is evidenee that Tahyna virus (CEV group) may be transmitted transovarially by *Cs. annulata* (Bardos et al., 1978), it should be considered of potential importance if it becomes established in New York.

Culiseta (*Culiseta*) *impatiens* (Walker)

Culex impatiens Walker, 1848. List Dipt. Brit. Mus. 1:5. Type-loc.: St. Martin's Falls, Albany River, Ontario, Canada.

Culex pinguis Walker, 1866. Lord's Nat. in Vancouver and B.C. 2:337. Type-loc.: British Columbia, Canada.

Culex absobrinus Felt, 1904. Bull. N.Y. State Mus. 79:318. Type-loc.: Elizabethtown, New York, United States.

DIAGNOSIS

FEMALE — SIZE: Large. *HEAD*: Proboscis and maxillary palpus dark-scaled, with scattered pale scales; occiput clothed with narrow, yellowish-white scales and with dark, erect scales dorsally, broad yellowish-white scales laterally; torus dark, sometimes with a few pale scales on inner surface. *THORAX*: Mesonotum dark brown, clothed with narrow brown to reddish-brown scales, with scattered pale, yellowish-white scales; 2 median spots of pale scales and 2 fine lines extending posteriorly to margin of prescutellar space, also with pale scales; scutellum with narrow yellowish-white scales and dark setae; pleura with patches of grayish-white scales; many yellow prespiracular setae. *ABDOMEN*: Most terga bronze-brown with distinct basal bands of pale scales; sternites pale-scaled with dark scales intermixed. *LEG*: Dark-scaled except some yellowish scales on posterior surface of femur and tibia and pale knee spot. *WING*: Length 5.5-6.0 mm; scales narrow, dark; crossvein r-m and vein M_{3+4} separated by less than length of either vein.

MALE TERMINALIA — Tergum VIII with a row of numerous (20-50) short spines on apical margin. *Lobes of tergum IX* each bearing several long setae. *Tergum X* heavily sclerotized and with strong teeth distally. *Phallosome* cylindrical, tapered to apex, open dorsally and ventrally. *Gonocoxite* about 2.0 times longer than wide; *basal mesal lobe* small, bearing one large and several smaller setae; *apicodorsal lobe* a slight protuberance, bearing a few long setae. *Gonostylus* curved, with several small setae; claw short, stout.

FOURTH INSTAR LARVA — HEAD: Antenna about 0.5 times length of head, spiculate; seta 1-A multiple, inserted near middle of antenna shaft; head hairs 5-7 multiple, subequal in size and number of branches. *THORAX*: Prothoracic hairs 1 and 2 long, single, hair 3 shorter, 3- 4-branched. *ABDOMEN*: Comb with numerous club-shaped scales in a patch, each scale clothed with spinules. *SIPHON*: Siphon index 2.5-3.0; pecten with 10-20 teeth on basal 0.25 of siphon, a row of long hairs following pecten to apical 0.25 of siphon; seta 1-S large, multiple, inserted within pecten near base of siphon. *SEGMENT X*: Seta 1-X shorter than saddle, with 2 to 4 branches; anal papillae longer than saddle, pointed.

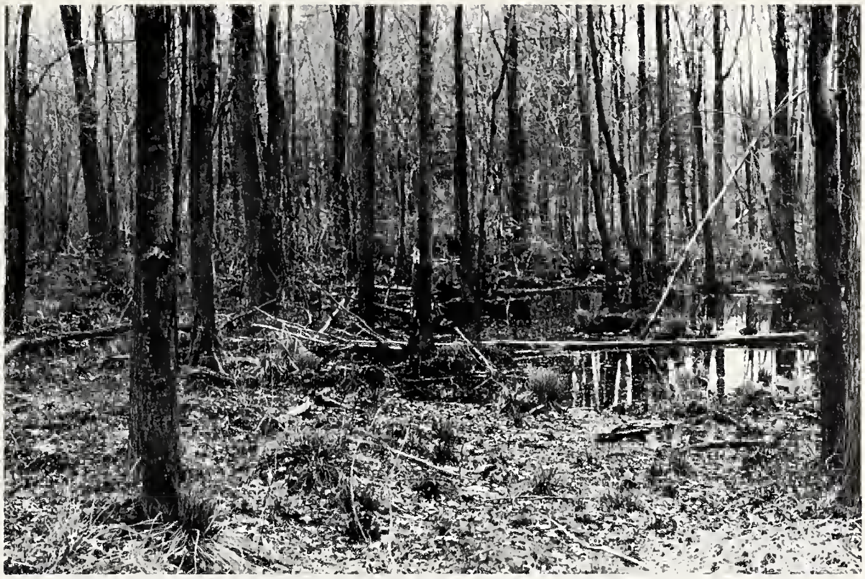


Figure 26. A temporary woodland pool, preferred habitat of *Culiseta impatiens*, *Cs. morsitans* and *Cs. inornata.*

BIONOMICS

In the "*Culiseta impatiens*" type of life cycle described by Pratt (1959), mated females overwinter, lay their eggs on the water surface the following spring and have a single generation per year. Overwintered females of *Cs. impatiens* are among the first mosquitoes found flying in late winter and early spring. Frohne (1952) collected hibernators in late March in Alaska and presumed them to be the large mosquito species that snowshoers had seen flying on warm sunny days in January and February. Frohne (1951) also reported that each year this species is a problem a month before any *Aedes* species is on the wing in Anchorage, Alaska. They can often be found flying on warm days in March and April in the Adirondacks.

Eggs are laid in rafts on the water surface early in the spring, and larvae are found in a variety of habitats. According to Hearle (1926) and Dyar (1922) the usual breeding sites are ground pools in dense forests, but *Cs. impatiens* larvae have also been found in grossly polluted impoundments (Frohne, 1951), wheel ruts, roadside ditches, holes left from uprooted trees and the margins of beaver dam ponds (Gjullin and Eddy, 1972; Rempel, 1953). Felt (1904) collected larvae, as did Jamnback (New York State Museum Collections) from cold woodland pools in the Adirondacks, and Matheson (1945) reported collecting larvae from "dark, clear woodland pools" in Tompkins County.

Preferred hosts of female *Cs. impatiens* are unknown but are probably large mammals, since humans are attacked readily. Rees (1943) observed that females attacked only at dusk in Utah and that they were easily frightened away. Carpenter and LaCasse (1955) reported that females also attacked during the day in an evergreen forest and other sheltered places. The author has likewise observed in the Adirondacks that this species will attack man readily at dusk, and also during the day in wooded areas. A few feet away, in open sun, females are easily frightened from their resting places but do not attack man. However, whenever the sun becomes covered by clouds, the females leave their resting places and attack readily.

DISTRIBUTION

Culiseta impatiens is widespread throughout the forested regions of North America from Alaska south to the northern border states and the mountain states of Wyoming and Colorado (Carpenter and LaCasse, 1955; Horsfall, 1955; Knight and Stone, 1977; Matheson, 1945; Rempel, 1953. It has recently been reported from Rhode Island (LeBrun et al., 1983). Barnes et al. (1950) considered the species "extremely rare" in New York and listed individual specimens collected from scattered localities in Franklin, Clinton, Essex, Cayuga, and Tompkins counties. The author has collected adult females from several additional localities in the Adirondack counties of Hamilton, Herkimer and Essex. Although this is not a common or abundant species, as many as a dozen or more females have been observed resting on a building on a warm day in late winter.

IMPORTANCE

This species is an aggressive biter, but it is not known to act as a vector of disease organisms, and it is considered to be of no medical importance. Because it is uncommon in New York it is of little importance here as a pest species.

Culiseta (*Culiseta*) *inornata* (Williston)

Culex inornata Williston, 1893. N. Am. Fauna 7:253. Type-loc.: Argus Mountains, California, United States.

Culex magnipennis Felt, 1904. Bull. N.Y. State Mus. 79:322. Type-loc.: Sodus Point, New York, United States.

DIAGNOSIS

FEMALE — SIZE: Large. *HEAD*: Proboscis, maxillary palpus and torus dark-scaled with scattered pale scales; occiput with narrow, yellowish-white, appressed scales and dark, erect scales dorsally, broad, pale scales laterally. *THORAX*: Mesonotum mostly clothed with golden-brown and yellowish scales, margins and prescutellar space with pale yellow scales; scutellum with pale yellow scales and dark setae; pleura with large patches of grayish-white scales. *ABDOMEN*: Terga clothed with dark brown scales and with basal bands of pale scales, widened laterally to extend the full length of each segment; tergite I with pale basal band enlarged medially into a patch and tergite VIII almost entirely pale scaled; sternites pale scaled. *LEG*: Dark brown with scattered pale scales on femur, tibia and 1 or 2 tarsal segments, pale-scaled on posterior surface; pale knee spots present at apex of tibia. *WING*: Length 5.0-6.0; scales on costa, subcosta and radius dark and white intermixed, broader and more numerous than scales on other veins; crossvein r-m and vein M_{3+4} separated on media by less than the length of either vein.

MALE — HEAD: Maxillary palpus without long setae; terminal segment broad, flattened. *TERMINALIA*: *Lobes of tergum IX* sclerotized, with many stout spines. *Tergum X* with an ovoid, striated structure at base, sclerotized and toothed apically. *Phallosome* composed of 2 sclerotized rod-like plates, open dorsally and ventrally, tapering distally. *Gonocoxite* about 2.0 times longer than wide, bearing short setae on inner aspect, long setae on outer aspect; *basal mesal lobe* prominent, conical, with large spine-like setae apicodorsally and smaller setae subapically; apical lobe absent. *Gonostylus* tapered, with short, bifurcate claw.

FOURTH INSTAR LARVA — HEAD: Antenna about 0.5 times length of head, spiculate; seta 1-A multiple, inserted at about middle of antenna shaft; head hairs 5-7 multiple, barbed, hair 6 somewhat longer and with fewer branches than hairs 5 or 7. *THORAX*: Prothoracic hairs 1 and 2 long, usually single; hair 3 long, 2- 3-branched. *ABDOMEN*: Comb composed of numerous club-shaped scales in a patch, each scale clothed with fine spinules. *SIPHON*: Siphon index about 3.5; pecten with 10-20 teeth on basal 0.25 of siphon, a row of long hairs following pecten to near apical 0.25 of siphon; seta 1-S large, multiple, inserted within pecten near base of siphon. *SEGMENT X*: Seta 1-X with 1-5 branches (usually 2) almost as long as saddle or longer; anal papillae at least length of saddle, pointed.

BIONOMICS

Culiseta inornata is a multivoltine species having a "*Culex pipiens*" type of life cycle in which fertilized females overwinter (Pratt, 1959). Rafts containing about 100-200 eggs are deposited on the water surface, the first rafts deposited by overwintered females which are active early in the spring, often when there is still snow on the ground and much of the water surface is still frozen over. These females are especially active on warm days and bite man readily at this time. According to Owen (1937), overwintered females feed only once and usually die soon after depositing an egg raft.

Larvae hatching from eggs laid by overwintered females are usually most abundant in temporary snow melt pools at about the same time as larvae of several species of northern *Aedes*, including *Ae. abserratus*, *Ae. excrucians*, *Ae. punctor* and others. The author has collected second and third instar larvae of *Cs. inornata* as early as May 12 and fourth instar larvae as early as May 16 in the Adirondacks, much earlier than larvae of most species which overwinter as adults (Barr, 1958). In late summer, larvae of *Cs. inornata* are usually found in permanent and semi-permanent water. They have been reported from a variety of habitats including foul, deoxygenated water (McLintock, 1952), woodland pools and snow pools (Barr, 1958) and marshes (Ross, 1947). In New York State the author has collected this species from open marshes containing considerable amounts of emergent vegetation; from weedy edges of large ponds; large leaf-lined woodland pools, both temporary and semi-permanent; and from deep, grassy roadside ditches, some containing saline water.

In the southern United States and northern Mexico, this species has several generations through the winter months, whereas in the North there appear to be two generations a year, in the spring and in the late summer, with a period of inactivity during the hot summer weather (Ross, 1947). This appears to be the case in New York because larvae are usually found in mid-May through late June and in mid-August through early October, but they are only rarely collected in July.

Females attack man readily in the spring upon emerging from hibernation (Ross, 1947), but at other times they are reluctant to bite humans and apparently prefer to feed on large mammals, such as horses and cows (Anderson et al., 1967; Edmand and Downe, 1964; Reeves and Hammon, 1944; Shemanchuk et al., 1963; Tempelis, 1964; Tempelis and Washino, 1967; Tempelis et al., 1967; Yates, 1953). Wright and DeFoliart (1970) also collected *Cs. in-*

ornata feeding on small mammals including raccoon, red fox, domestic rabbit and ground squirrel and on domestic chicken.

DISTRIBUTION

The distribution of *Cs. inornata* is given by Carpenter and LaCasse (1955) and Knight and Stone (1977) as the United States, southern Canada and northern Mexico. Rempel (1953) reported this species to be the one most commonly encountered in houses in the fall (in Saskatchewan), seeking a place to hibernate. He also reported that this species constituted an important part of the mosquito fauna during the 1941 epidemic of equine encephalitis in Saskatchewan. Barnes et al. (1950) reported that the species occurs sparingly in scattered localities in New York State. The author has found it throughout most of the State, primarily in marshes on Long Island, bogs in the Adirondacks and large marshes and swamps of the central and western areas of the state. It is sometimes locally abundant in these areas, especially in the early spring, although it is seldom a major nuisance.

IMPORTANCE

Culiseta inornata is not normally attracted to man, and even in the spring, when it does bite man, it is not usually found in very great abundance. Therefore, it does not constitute a major annoyance. However, several encephalitis viruses have been isolated from this species, including Western equine encephalitis (Hammon et al., 1945a) and several strains of California group viruses as summarized by Sudia et al. (1971). Reeves and Hammon (1946) have also demonstrated the ability of this species to transmit Japanese B encephalitis virus in the laboratory. In view of the proven ability of this species to harbor and transmit viruses it should be considered a potential vector, if not to man, then possibily to domestic reservoir hosts.

Tribe Mansoniini

According to the classification of Knight (1978), Knight and Stone (1977) and Ward (1984), the tribe Mansoniini contains the genera *Mansonia* and *Coquillettidia*, with 81 species. *Mansonia* is represented by two species and *Coquillettidia* is represented by one species in the United States.

Genus *Coquillettidia* Dyar

IMPORTANT REFERENCES: Ronderos and Backman, 1962:48-51 (elevation to generic status); Mattingly, 1971:1 (disagreement with generic treatment of *Coquillettidia*).

Subgenus *Coquillettidia* Dyar

Coquillettidia Dyar, 1905. Proc. Entomol. Soc. Wash. 7:47. TYPE SPECIES: *Culex perturbans* Walker, by original designation.

The genus of *Coquillettidia* was elevated from its position as a subgenus of *Mansonia* to generic status in 1962 by Ronderos and Backman, based on biological and morphological characters of adults and preimaginal forms. Mattingly (1971) retained the classification of *Coquillettidia* as a subgenus of *Mansonia*. The genus is primarily tropical, having only one palaearctic species, *Cq. richardii* (Ficalbi) occurring in Europe, Siberia and Syria, and one Nearctic species, *Cq. perturbans* (Walker) occurring in North America. The latter is the only species of the genus represented in the New World.

Larvae and pupae of all known species attach to aquatic plants by means of a modified siphon or pupal trumpet. They secure oxygen for respiration from air cells of the host plants. This association appears to be host specific in some species, but not in *Cq. perturbans*. Larvae drop off the host plant into mud below when disturbed, but the tips of the trumpets are broken off if the pupae are detached, and they cannot reattach to another plant, nor can they obtain oxygen at the water surface (Belkin, 1962). Several species of *Coquillettidia* attack man readily, including *Cq. perturbans*, whereas other species apparently do not bite man.

Coquillettidia (*Coquillettidia*) *perturbans* (Walker)

Culex perturbans Walker, 1856. Ins. Saund. Dipt. 1:428. Type-loc.: United States.

Culex testaceus Van der Wulp, 1867. Tijdschr. Entomol. 10:128. Type-loc.: Kumlien, Wisconsin, United States.

Culex ochropus Dyar and Knab, 1907, J. N.Y. Entomol. Soc. 15:100. Type-loc.: Center Harbor, New Hampshire, United States.

DIAGNOSIS

FEMALE (figs. 169-171) — *SIZE*: Medium to moderately large. *HEAD*: Proboscis dark-scaled with scattered pale scales basally and a median ring of pale scales; maxillary palpus dark, with scattered pale scales; occiput with pale lanceolate scales and dark, erect, forked scales; torus with a patch of grayish-white scales on inner surface. *THORAX*: Mesonotum dark brown to black with mostly dark brown scales medially, a few pale, dingy-yellow scales intermixed; the lateral and anterior margins lined with dingy-yellow to pale golden scales and with a posterior half stripe of these pale scales; pleura with patches of grayish-white to yellow scales; prespiracular and postspiracular setae absent. *ABDOMEN*: Most terga with baso-lateral patches of pale yellow scales and sometimes with narrow basal bands of pale scales; ventor with intermixed pale and dark scales; eighth segment blunt. *LEG*: Femur and tibia dark-scaled with scattered pale scales; hindfemur with a narrow subapical band of pale scales; tibia with narrow pale apical bands; basitarsus pale with median band, other tarsal segments with basal half pale-scaled, apical half dark-scaled; scales on legs usually erect, giving a shaggy appearance. *WING*: Length 4.0-5.0 mm; scales broad, mixed dark and pale.

MALE TERMINALIA (fig. 197) — *Tergum IX* with widely separated, sclerotized lobes, each having several setae. *Tergum X* heavily sclerotized, with heavy apical teeth; *dorsal arm* large, curved dorsally toward ninth tergal lobes. *Phallosome* sclerotized, open dorsally and ventrally, constricted medially, bluntly pointed apically, each plate with longitudinal row of teeth directed ventrally. *Claspette* absent. *Gonocoxite* about 2.0 times longer than wide, clothed with setae and scales; *basal mesal lobe* triangular, with thick, blunt rod and a smaller spine at apex; *apicodorsal lobe* absent. *Gonostylus* curved, wide at base, constricted medially, expanded past middle, tapered to an apical point; with a row of small setae on apical 0.25; claw short, peg-like.

FOURTH INSTAR LARVA (figs. 167, 168) — *HEAD*: Head about 1.5 times wider than long; antenna more than twice as long as head, spiculate on basal third; seta 1-A large, multiple, barbed, inserted on basal 0.33 of antennal shaft; 2 small single setae inserted at about middle of shaft; head hairs 4 and 5 small, multiple, smooth; hairs 6 and 7 large, multiple, barbed. *THORAX*: Prothoracic hairs 1 and 2 long, single; hair 3 long, multiple. *ABDOMEN*: Lateral hair 6 single on segments I and VI; comb with 8-16 scales in irregular row, each scale thorn-like, fringed on basal half with short spinules. *SIPHON*: Siphon short, strongly attenuated, heavily sclerotized and slightly curved beyond middle; attenuated part with several tooth-like projections dorsally, hooks at apex; a long recurved dorsal spine, a long, single lateral hair and a long, multiple lateral hair at base; pecten absent. *SEGMENT X*: Saddle complete; seta 1-X a multiple tuft, inserted well before distal margin, shorter than saddle; dorsal brush a long, multiple lower tuft and a shorter, multiple upper tuft; ventral brush large; anal papillae shorter than saddle, pointed.

BIONOMICS

Eggs of *Coquillettidia perturbans* are laid in rafts similar to those of *Culex* species, which contain an average of about 195 eggs. Rafts are deposited on "the most sheltered water surface available in the presence of suitable host plants" (Armstrong, 1941). McNeel (1932) found egg rafts floating in the meniscuses about emergent stems of various aquatic plants. Armstrong found that egg rafts were most abundant on Cape Cod, Massachusetts, between July 15 and August 10. Eggs hatch within 6-7 days after being deposited (Carpenter and LaCasse, 1955), and emerging larvae drop into the mud for several weeks, after which larvae in all instars can be found attached to plant roots.

Most larvae are in the fourth instar by the end of October. They are inactive through the winter and become active again in early April on Cape Cod, later at higher elevations or farther north. Because they detach when disturbed and burrow into the mud, where they are extremely difficult to detect, larvae of *Cq. perturbans* require special collecting techniques. One method is to pull out suspected host plants and wash the mud from the roots through a sieve (McNeel, 1931). An easier and usually more efficient method is to use a trap such as that described by Bidlingmayer (1954) which collects larvae as they are forced to rise to the water surface for respiration after host plants have been removed.

Larvae pupate beginning in early June on Cape Cod and Long Island with the greatest amount of pupation occurring from June 20-July 20. The pupal stage lasts about 9 days, during which time the pupa cannot detach from the plant stem or root. When ready to emerge, pupae detach from the host plant and float to the water surface, moving actively about to select a satisfactory site for emergence to the adult stage.

Female *Cq. perturbans* bite man readily and also feed on a variety of other mammals, birds, amphibians (frogs) and, to a small extent, on reptiles (Crans, 1964; Means, 1968; Murphey et al., 1967; Wright and DeFoliart, 1970). During the day adults normally rest in low brush and vegetation in cool shady locations (Armstrong, 1941). Although Armstrong found that they did not bite during the day, Twinn (1931) reported that they were often pests, especially near their sources. Female *Cq. perturbans* are most active at dusk and after midnight when they enter houses readily to feed (Armstrong, 1941; Headlee, 1931). The author has found *Cq. perturbans* to be active in early morning, at dusk, during the night, and also in densely shaded locations during the day.

DISTRIBUTION

Coquillettidia perturbans is distributed throughout Canada, the United States and Mexico (Knight and Stone, 1977). The European distribution listed by Horsfall (1955) refers to *Cq. richardii* rather than *Cq. perturbans.* The species is fairly common throughout New York State. It is quite abundant in some areas, especially in the southeastern part of the State, around New York City and Long Island, as well as in the central part of the State, near the Finger Lakes.

IMPORTANCE

The viruses of eastern and California encephalitis have been isolated from *Cq. perturbans* (Howitt et al., 1949; Sudia et al., 1971). Because of this and because *Cq. perturbans* attacks man readily, this species is to be considered a potential vector and economically important to the State.

Tribe Orthopodomyiini

Genus *Orthopodomyia* Theobold

Orthopodomyia Theobald, 1904. Entomologist 37:236. TYPE SPECIES: *Orthopodomyia albipes* Leicester, by monotypy.

Bancroftia Lutz, *in* Bourroul, 1904. Mosq. de Brasil: 40, 59. TYPE SPECIES: *Bancroftia albicosta* Lutz, by monotypy.

Pneumaculex Dyar, 1905. Proc. Entomol. Soc. Wash. 7:46. TYPE SPECIES: *Culex signifer* Coquillett, by original designation.

Newsteadina Theobald, 1908 (1909). Ann. Trop. Med. Parasitol. 2:297. TYPE SPECIES: *Culex arboricollis* Charmoy, by original designation.

Thomasina Newstead and Carter, 1911. Ann. Trop. Med. Parasitol. 4:553. TYPE SPECIES: *Mansonia longipalpus* Newstead and Carter, by original designation.

IMPORTANT REFERENCE: Zavortink, 1968 (taxonomic revision).

The genus *Orthopodomyia* has been little studied and is poorly known because, with few exceptions, the adults are not attracted to and do not bite man. The genus is worldwide in distribution, but is largely restricted to the tropical and warm temperate regions. Most of the information included here is derived from an extensive monograph by Zavortink (1968), who included 24 species in 8 distinct groups. Three additional species were listed by Ward (1984). The *signifera* group, which is Holarctic in distribution, contains 6 species with two sympatric Nearctic species represented in New York, *Or. alba* and *Or. signifera.*

The immature stages of *Orthopodomyia* occur only in tree holes, other natural plant containers and artificial containers. Unlike *Toxorhynchites* larvae, *Orthopodomyia* are filter-feeders and are not cannibalistic, even when the breeding sites contain large numbers of larvae.

Little is known regarding the hosts of *Orthopodomyia* except that two Oriental species bite man and three species, including *Or. alba* and *Or. signifera*, feed on avian blood.

Since most species do not bite man, *Orthopodomyia* is generally considered to be of little importance medically. However, eastern encephalitis virus has been isolated from *Or. signifera* (Vargas, 1960) and the same species has been termed a "good" and "excellent" potential vector of eastern and western encephalitis, respectively, by Chamberlain et al. (1954). Zavortink (1968) believes *Orthopodomyia* females may be of considerable importance in the maintenance of arboviruses in sylvan environments and in transmission to domestic birds.

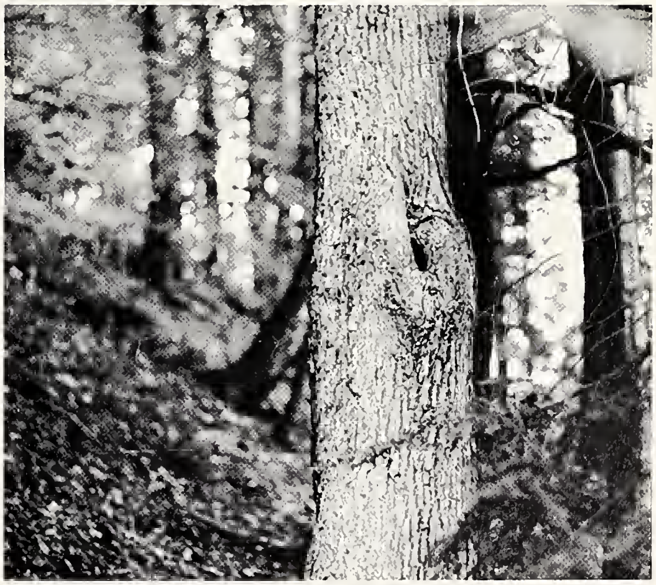


Figure 27. A small-entrance treehole typical of the preferred habitat of *Orthopodomyia signifera* and *Or. alba.*

KEYS TO SPECIES OF THE GENUS *ORTHOPODOMYIA*

FOURTH INSTAR LARVA

1. Head capsule medium to dark brown; abdominal segment VIII (and often others) usually with dorsal sclerotized plate; pentad hair 3 approximately length of saddle (fig. 173) . . . .*signifera*
   Head capsule pale (fig. 174); dorsal plates absent; pentad hair 3 less than 0.5 length of saddle . .*alba*

FEMALES

1. Midtarsus with segments 3-5 entirely dark (not always separable from *Or. signifera*) (fig. 176) . . . .*alba*
   Midtarsus with pale scales on dorsal side of segments 4 and 5 (not always separable from *Or. alba*) (fig. 177) . . . .*signifera*

Orthopodomyia alba Baker

Orthopodomyia alba Baker, 1936. Proc. Entomol. Soc. Wash. 38:1. Type-loc.: Ithaca, New York, United States.

For additional references see Zavortink, 1968:47-48.

DIAGNOSIS

FEMALE (figs. 176, 178, 180) — *SIZE*: Moderate. *HEAD*: Proboscis and maxillary palpus dark with longitudinal lines of white scales dorsally; occiput with narrow, white scales and dark, erect, forked scales dorsally, white scales laterally; torus dark with white scales on inner surface. *THORAX*: Mesonotum clothed with long, dark setae and brown scales, with three pairs of narrow, longitudinal lines of silver-white scales; pleura with patches and lines of silver-white scales; lower meskatepisternal setae 0-2. *ABDOMEN*: Most terga dark-scaled with narrow, pale basal bands. *LEG*: Femur and tibia dark with white scales intermixed; fore- and midtarsi with narrow white rings at apex and base of some segments; hindtarsus with broad white bands at base and apex of all segments. *WING*: Length about 3.8-4.2 mm; scales broad, oval, intermixed brown and white; base of vein R_{4+5} usually dark-scaled.

MALE TERMINALIA (fig. 200) — *Tergum VIII* with median, tongue-like, emarginate protuberance on posterior margin, overlapping anterior margin of tergum IX. *Tergum IX* emarginate anteriorly, curved posteriorly; lobes indistinct, represented by 2-3 long, fine setae. *Tergum X* heavily sclerotized and with teeth apically. *Phallosome* broad basally, narrowed and truncate apically, with a few subapical teeth. *Claspette* absent. *Gonocoxite* about 3 times longer than wide, with setae and scales; with 1 or 2 long, heavy curved spines near basal lobe; *basal mesal lobe* conical, with a few large apical spines and several smaller setae; *apicodorsal lobe* absent. *Gonostylus* about 0.6 times length of gonocoxite, narrow, curved; with a few small setae in a line on distal half; *claw* apical, divided apically into small comb-like teeth.

FOURTH INSTAR LARVA (figs. 174, 175) — *HEAD*: Antenna about 0.5 times length of head, tapered, smooth; seta 1-A multiple, inserted near basal 0.25 of antenna shaft; head hairs 4-7 multiple, barbed, hairs 5 and 6 longer than 4 and 7. *ABDOMEN*: Lateral abdominal hair 6 long, usually double or triple on segments I and II; comb composed of an anterior row of about 10-20 scales and a posterior row of about 8-12 scales; most scales long, pointed, fringed on basal half with small subequal spinules, some scales on anterior row smaller, fringed apically with subequal spinules; pentad hair 3 small, barbed, with 2 to 5 branches. *SIPHON*: Siphon index about 2.0 to 2.5; pecten absent; seta 1-S inserted before middle of siphon, 2- 4-branched, nearly as long as width of siphon at point of insertion. *SEGMENT X*: Saddle variable, either complete or sometimes not quite meeting ventrally; small transverse sclerotized area near base of segment; seta 1-X shorter than saddle, 2- 4-branched; dorsal brush a long single lower caudal hair and a shorter multiple upper tuft; anal papillae shorter than saddle, bud-like, blunt.

BIONOMICS

Orthopodomyia alba and *Or. signifera* are sympatric species, often occurring together in the same tree holes. Zavortink (1968) stated that because the larva of *Or. alba* differs from the larva of *Or. signifera* (e.g., more hairiness, lack of epidermal pigment, shorter anterior row of comb scales); this species is able to occupy a different niche in the same tree hole habitat as *Or. signifera*. While *Or. alba* may overwinter in the egg stage (Pratt, 1959), larvae can also overwinter and survive complete freezing in New York (Baker, 1936; Horsfall, 1955; Matheson, 1945). Wilkins and Breland (1951) found that *Or. alba* overwintered in the adult stage in the South and Zavortink (1968) reported that in the Southwest, larvae in all stages of development could be collected at any time of the year, as could the larvae of *Or. signifera*.

Larvae and adults of *Or. alba* and *Or. signifera* are commonly found in association with each other and apparently have much the same life cycle, with the exceptions noted for overwintering. Eggs are usually deposited in tree holes, especially those having small external openings and deep cavities which do not dry out completely (fig. 27), such as those in oak trees and in trees in which the water within the cavity is supplied by the tree, independent of precipitation (Wilkins and Breland, 1951; Zavortink, 1968). Such trees in the Northeast include cottonwood, willow, elm and horsechestnut (Zavortink, 1968). Eggs are deposited either on the sides of the cavity just above the water line, with the newly hatched larvae descending into the water (Howard et al., 1917), or on the water surface (Horsfall, 1955). Immature stages may also be found in dark artificial containers which simulate tree holes (Zavortink, 1968). Breland (1947) collected live larvae and pupae in the moist debris of a tree hole with no standing water.

Although development is slow in cool weather, Horsfall (1955) reported multiple generations during the summer. The author has collected larvae in all stages as well as pupae from the same site, apparently from overlapping generations. Larvae removed from a tree hole and kept in a closed wooden container under the same weather conditions to simulate a natural breeding site, developed from first instar larva to adult in 10 days during July.

Adults are most commonly collected resting in tree holes, caves and on tree bark in the vicinity of their larval breeding sites. Zavortink (1968) reported that females fed readily on several birds, including canary, brown towhee and house sparrow but could not be induced to take blood from a human arm.

DISTRIBUTION

Orthopodomyia alba has been reported from a small area in the Provinces of Quebec and Ontario, Canada (Smith and Trimble, 1973; Wood et al., 1979), from scattered localities in eastern and southern United States from New York to Texas and south as far as Coahuila, Mexico. In New York it has been reported from Ithaca, Tompkins County, from Guilderland, Albany County (N.Y.S. Museum Coll.), from several locations in Nassau County (W. G. McClure, pers. comm.) and from Islip, Suffolk County (Guirgis, 1984). The species probably occurs elsewhere in the State but has not been reported because females are not attracted to man and larvae are found only in inconspicuous tree holes having small external openings.

IMPORTANCE

Since *Or. alba* is not known to take human blood it is of no direct medical importance. However, this species is known to feed on birds and may be involved in the transmission of arboviruses from sylvan environments to domestic fowl, especially since eastern encephalitis virus has been isolated from *Or. signifera* in Mexico (Vargas, 1960; Zavortink, 1968).

***Orthopodomyia signifera* (Coquillett)**

Culex signifer Coquillett, 1896. Can. Entomol. 28:43. Type-loc.: Washington, District of Columbia, United States.

Orthopodomyia californica Bohart, 1950. Ann. Entomol. Soc. Am. 43:399-400. Type-loc.: Elkhorn Ferry, near Sacramento, California, United States.

For additional synonymy and references, see Zavortink, 1968:35-37.

DIAGNOSIS

FEMALE (figs. 177, 179, 181) — Identical to *Or. alba* except lower meskatepisternal setae are 4-10 in number and there are usually a few pale scales at the base of wing vein R_{4+5} (Darsie and Ward, 1981; Zavortink, 1968).

MALE TERMINALIA — Almost identical to *Or. alba* (see Zavortink, 1968 for minor differences).

FOURTH INSTAR LARVA (figs. 172, 173) — *HEAD*: Antenna about 0.5 times length of head, smooth, tapered; seta 1-A large, multiple, barbed, inserted just before middle of antenna shaft; head hairs 4-7 multiple, barbed, hairs 5 and 6 larger than 4 and 7. *ABDOMEN*: Lateral abdominal hair 6 short, usually 4-6 branched on segments I and II; large sclerotized dorsal plate on segment VIII, sometimes also on VI and VII; comb with an anterior row of 15-25 scales and a posterior row of 5-10 scales, most scales long, pointed, fringed basally with small spinules, some smaller scales in anterior row fringed apically with subequal spinules; pentad hair 3 large, multiple, barbed. *SIPHON*: Siphon index 3.0-3.5; pecten absent; seta 1-S large, multiple, barbed, inserted on basal half of siphon. *SEGMENT X*: Saddle complete; a sclerotized patch at base of segment; seta 1-X single, about as long as saddle; dorsal brush a long, single, lower hair and a shorter, multiple, upper tuft; anal papillae usually shorter than saddle, blunt, dorsal pair larger than ventral pair.

BIONOMICS

The life cycle of *Orthopodomyia signifera* is similar to that of *Or. alba*, a sympatric species with which *Or. signifera* is often found associated. This species differs from *Or. alba* in that the egg stage of *Or. signifera* overwinters in New York State, whereas the larva of *Or. alba* overwinters, frozen in tree holes (Baker, 1936; Matheson, 1945; Horsfall, 1955).

Orthopodomyia signifera, like *Or. alba*, has been reported in tests to feed on birds, including canary, brown towhee and house sparrow (Zavortink, 1968). Thibault (1910) also reported that females of *Or. signifera* entered dwellings and bit humans frequently in Arkansas, but this report has not been confirmed by others (Zavortink, 1968).

DISTRIBUTION

Orthopodomyia signifera is found in Ontario, Canada (Shipp and Wright, 1978; Smith and Trimble, 1973), most of the United States, primarily the southeastern states, into Mexico and in Cuba and the Virgin Islands. It has been collected rarely from scattered localities throughout New York State but is probably more common than is indicated by collection records because females are not attracted to man and larvae are normally found only in inconspicuous tree holes.

IMPORTANCE

Like *Or. alba*, this species is of no direct medical importance because it does not feed on man. Both of these species feed readily on birds and may be involved in maintenance of eastern or western encephalitis in sylvan populations, or in transmission to domestic fowl (Zavortink, 1968; Chamberlain et al., 1954; Vargas, 1960). However, since both species are uncommon in New York they probably are of little importance here.

Tribe Sabethini

The tribe Sabethini contains 12 genera, with 377 species, subspecies and varieties recognized by Knight and Stone (1977), Knight (1978) and Ward (1984). The species of this tribe are nearly all tropical in distribution, with only four, all in the genus *Wyeomyia*, reported from the United States.

Genus *Wyeomyia* Theobold
Subgenus *Wyeomyia* Theobald

Wyeomyia Theobald, 1901a,b. J. Trop. Med. 4:235; Mon. Cul. 1:98, 2:267. TYPE SPECIES: *Wyeomyia grayii* Theobald, by subsequent designation (Neveu-Lemaire, 1902b:223).

Wyeomyia, subgenus *Phyllozomyia* Dyar, 1924. Insec. Inscit. Menst. 12:112. TYPE SPECIES: *Aedes smithii* Coquillett, by original designation.

For additional synonymy see Knight and Stone, 1977:333.

Wyeomyia is essentially a tropical genus, and only four species occur in the United States. *Wyeomyia smithii* (Coquillett) is the only species which has been reported from New York, but *Wy. haynei* Dodge, a southeastern species, may also occur here as it has been reported from Maryland (Bickley and Mallack, 1978).

KEYS TO SPECIES OF THE GENUS *WYEOMYIA*

FOURTH INSTAR LARVAE*

1. Dorsal pair of anal papillae absent or sometimes a pair of very small swellings; seta 14-M more stout than seta 14-P (figs. 182, 183) . . . . *smithii*
   Dorsal pair of anal papillae about one-third as large as ventral pair; seta 14-P more stout than seta 14-M . . . . *haynei*

FEMALES*

1. Scutellum with a patch of silvery scales on midlobe (fig. 186) . . . . *haynei* Dodge
   Scutellum with dark scales only . . . . *smithii* (Coquillett)

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* Adapted from Dodge (1947) and Darsie and Ward (1981).

Wyeomyia (*Wyeomyia*) *haynei* Dodge

Wyeomyia haynei Dodge, 1947. Proc. Entomol. Soc. Wash. 49:118. Type-loc.: Columbia, South Carolina, United States.

DIAGNOSIS

FEMALE (fig. 186) — Indistinguishable from *Wy. smithii* except for patch of silvery scales on scutellum, corresponding to all dark scales on *Wy. smithii.*

MALE TERMINALIA — Indistinguishable from *Wy. smithii.*

FOURTH INSTAR LARVA — *HEAD*: Length subequal to width; antenna smooth, less than 0.5 times length of head; seta 1-A single, inserted well beyond middle of antenna shaft, extending beyond tip; head hairs 4-7 single, about length of antenna. *THORAX*: Seta 14-P more stout than 14-M, subequal in length. *ABDOMEN*: Comb with 10-30 scales in a single row, individual scales progressively smaller ventrally and fringed with small, delicate spinules. *SIPHON*: Siphon index about 4.0; pecten absent; siphon with numerous long, single, sparsely barbed hairs. *SEGMENT X*: Saddle extending about halfway down segment; seta 1-X very long, barbed, usually 2-branched; upper and lower caudal tufts of dorsal brush each long, barbed, double; ventrolateral tuft usually double, barbed; 2 pair of anal papillae, bulbous, ventral pair longer than saddle, about 3 times longer than dorsal pair.

BIONOMICS

Wyeomyia haynei breeds in the water-holding leaves of the southeastern subspecies of the pitcher plant, *Sarracenia purpurea venosa* Rafinesque. Biologically, as well as morphologically, this species is very similar to the northern species, *Wy. smithii.* Like *Wy. smithii*, the females are not known to feed on blood.

DISTRIBUTION

Wyeomyia haynei occurs in southeastern United States as far north as Maryland (Bickley and Mallack, 1978), and may extend as far as the range of its host plant into southern New Jersey (Dodge, 1947). Dodge reported that some of the specimens identified as *Wy. smithii* from the Botanical Garden in Washington, D. C. were probably *Wy. haynei.* It is possible, though unlikely, that the range of *Wy. haynei* could extend into New York State.

IMPORTANCE

The females of *Wy. haynei* do not bite man, and they might not feed on blood at all; therefore, the species is considered of no medical or economic importance.

Wyeomyia (*Wyeomyia*) *smithii* (Coquillett)

Aedes smithii Coquillett, 1901. Can. Entomol. 33:260. Type-loc.: Lahaway, New Jersey, United States.

DIAGNOSIS

FEMALE (figs. 184, 185) — *SIZE*: Small. *HEAD*: Proboscis and maxillary palpus dark-scaled; torus dark brown, naked; occiput clothed with broad, dark, metallic blue-green scales; *THORAX*: Mesonotum dark brown with large grayish-brown, somewhat metallic scales; pleura with dense patches of silver-white scales; scutellum light brown, clothed with dark brown scales and with dark brown setae. *ABDOMEN*: laterally compressed; dorsum clothed with dark brown to black, somewhat metallic scales, ventor yellow-white to silver-white, meeting laterally in a longitudinal line. *LEG*: Coxae with patches of silver-white scales; femur and tibia with dark metallic scales anteriorly, pale scales posteriorly; fore- and hindtarsi dark, segments 2-4 of midtarsus with white scales. *WING*: Length 2.5 mm; scales narrow, dark.

MALE TERMINALIA (fig. 199) — *Lobes of tergum IX* widely separated, each with 4 to 6 long setae. *Tergum X* sclerotized and toothed apically, with 2 or 3 subapical setae. *Phallosome* bulbous, narrowed at base, rounded distally with slight point at tip, open ventrally, closed dorsally. *Claspette* absent. *Gonocoxite* about 3 times longer than wide; 2 or 3 long setae on dorsal side near base, short setae and scales along lateral edge; *basal mesal lobe* triangular or subquadrate with many small setae (according to Carpenter and LaCasse (1955) this may not be a true basal lobe); *apicodorsal lobe* absent. *Gonostylus* about length of gonocoxite with a thick, short stem and a longer apical head having unusual structures as shown in figure.

FOURTH INSTAR LARVA (figs. 182, 183) — *HEAD*: Length subequal to width; antenna smooth, less than 0.5 times length of head; seta 1-A single, inserted well beyond middle of antenna shaft, reaching beyond tip; head hairs 4-7 long, single. *THORAX*: Seta 14-M longer and more stout than 14-P. *ABDOMEN*: Comb with 4-20 scales (usually 8-12) in a single row, each scale fringed with small spinules. *SIPHON*: Siphon index 4.0-5.0; pecten absent; siphon with numerous long, single hairs. *SEGMENT X*: Saddle extending about halfway down segment; seta 1-X very long, 2- 4-branched (usually triple), barbed; upper and lower caudal tufts of dorsal brush each long, barbed, usually double; ventrolateral tuft usually triple, barbed; one pair of anal papillae, bulbous, 2-2.5 times length of saddle.

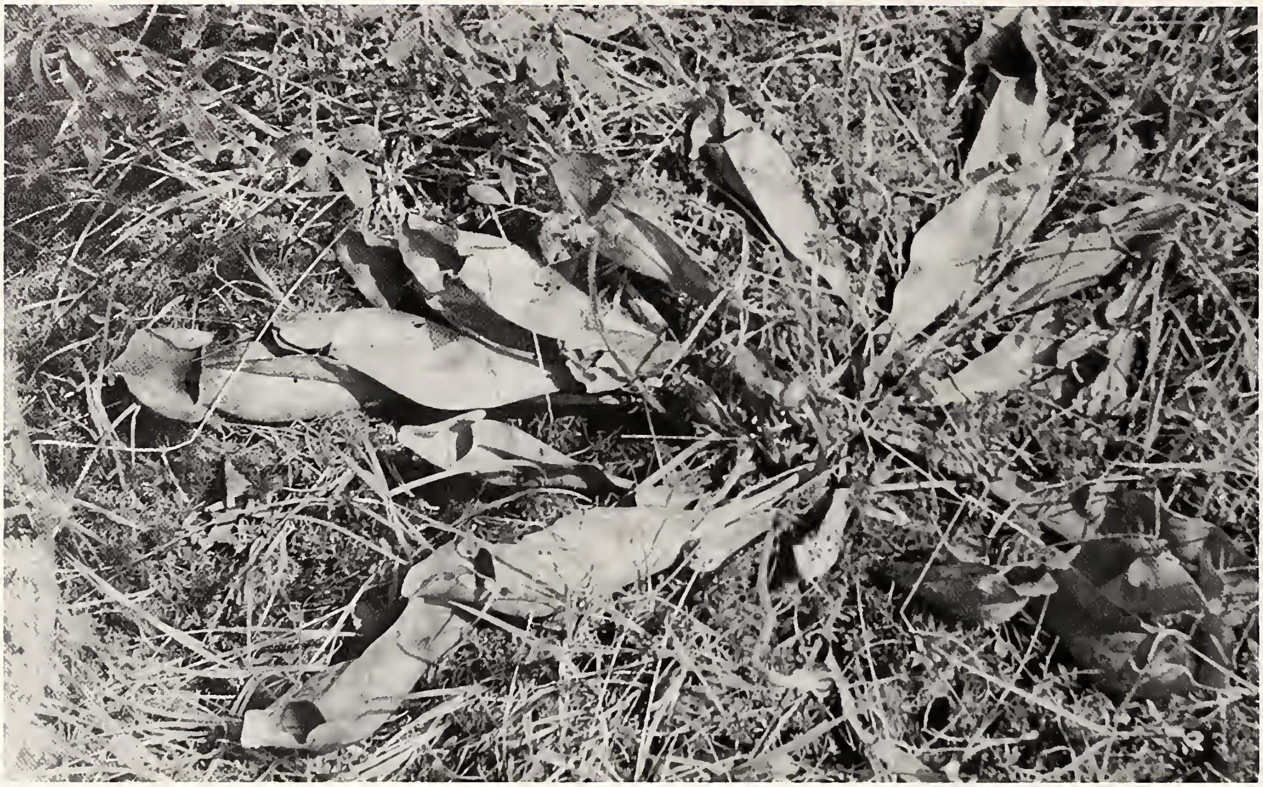

Figure 28. Larvae of Wyeomyia smithii are found only in the waterholding leaves of the pitcher plant.

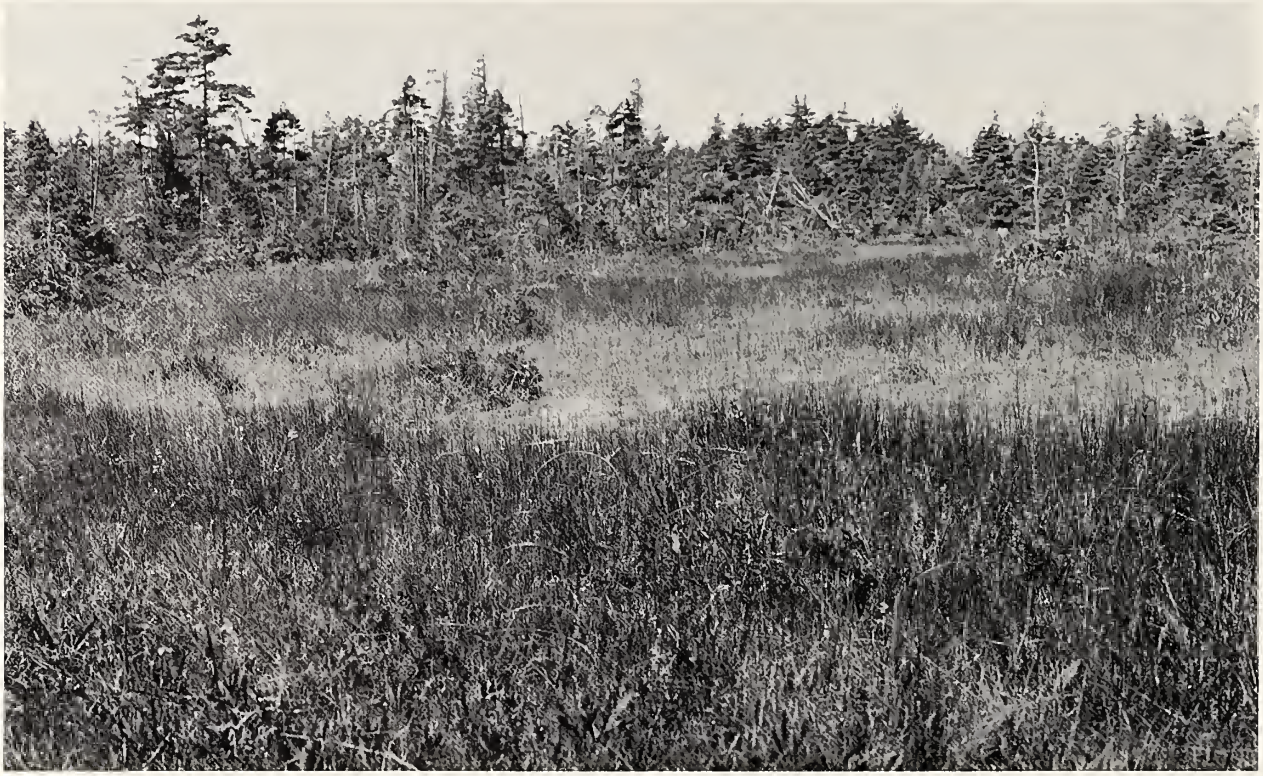

Figure 29. A pitcher plant bog in Genesee County.

BIONOMICS

The life history of *Wyeomyia smithii* was described in detail by Smith (1902). The immature stages of *Wy. smithii* have been reported only from the water-holding leaves of the "typical" northern variety of the insectivorous pitcher plant, *Sarracenia purpurea* (Barr, 1958; Dodge, 1947). Eggs are laid singly or in small groups, either on the water surface or attached to the sides of the older leaves just above water level during the summer. Late in the season eggs are laid on the sides of young leaves, even before water has collected in them (Carpenter and LaCasse, 1955; Smith, 1902). The species overwinters as larvae frozen in a solid block of ice within the plant leaf. Although overwintering larvae survive several months of freezing in this manner, Owen (1937) reported that larvae collected in the summer were killed when subjected to a temperature of −14° C.

Overwintering larvae pupate in New York in late May and adults begin to appear 7-10 days later in early June. Generations are multiple and continuous until water freezes in the leaves, usually in late November. The length of time required for development varies considerably. Summer broods normally develop in about one month, but it has been observed that some larvae develop much faster than others (Smith, 1902, 1904). Of 50 newly-molted fourth instar larvae collected by the author at the same time from the same plant, 36 pupated and emerged as adults in 10 days, whereas the remaining 14 did not pupate for over 2 months, then emerged 9 days later. There were approximately equal percentages of males and females in each of these lots and all larvae had molted from third instar within 24 hours of each other. Smith (1902) found that some larvae collected in November remained as larvae until the following September. He also observed that overwintering larvae collected in ice and thawed in the laboratory became active but required several months to complete development. The author also has found that larvae collected in winter and reared in the laboratory usually do not complete development until late May or June, just as they would if allowed to remain frozen until they thawed naturally.

Respiration is apparently cutaneous since larvae are known to stay beneath the water surface for extended periods and, in fact, only rarely rise to the surface for air (Barr, 1958; Horsfall, 1955; Grossbeck, 1913; Smith, 1904). Larvae feed on insect fragments which settle in the bottom of the pitcher plant leaf (Horsfall, 1955) and also on the water surface (Smith, 1904).

Female *Wyeomyia smithii* are not known to bite man. In host preference tests conducted in Suffolk County, Long Island, New York, no specimens of this species were attracted to test animals (birds, mammals, reptiles or amphibians) even though several tests were conducted in areas where *Wy. smithii* was known to be abundant (Means, 1968).

DISTRIBUTION

Wyeomyia smithii is distributed throughout southeastern Canada and the northeastern United States, from Labrador and Newfoundland to South Carolina and Alabama, west to Minnesota. It occurs throughout New York State where the pitcher plant, *Sarracenia purpurea*, is found.

IMPORTANCE

Since this species is not known to bite man or animals it is considered of no medical or economic importance.

Tribe Uranotaeniini

Genus *Uranotaenia* Lynch-Arribalzaga

The genus *Uranotaenia* is probably of no economic importance because the females are not known to bite man (Belkin, 1962). Consequently, the genus has not been deeply studied and is poorly understood. Knight and Stone (1977), Knight (1978) and Ward (1984) list 203 species, subspecies and varieties in two subgenera, the subgenus *Pseudoficalbia* having been revalidated by Peyton (1972). Belkin, however, contends the genus may be as complex as *Aedes*, with several subgenera and many more species than are presently recognized.

Uranotaenia is worldwide in distribution, with the bulk of species occurring in the Old World tropics. Three species are known to occur in the United States, *Ur. anhydor* Dyar in the southwest, *Ur. lowii* Theobald in the south and *Ur. sapphirina* (Osten-Sacken) in the eastern and central United States.

IMPORTANT REFERENCE: Peyton, 1972:21 (revalidation of subgenus *Pseudoficalbia* Theobald).

Subgenus *Uranotaenia* Lynch-Arribalzaga

Uranotaenia Lynch-Arribalzaga, 1891a. Rev. Mus. La Plata I:375; II:163. TYPE SPECIES: *Uranotaenia pulcherrima* Lynch-Arribalzaga, by subsequent designation (Neveu-Lemaire, 1902b:227).

Anisocheleomyia Theobald, 1905c. Entomologist 38:52. TYPE SPECIES: *Anisocheleomyia nivipes* Theobald, by subsequent designation (Brunetti, 1914:55).

Pseudouranotaenia Theobald, 1905b. J. Econ. Biol. 1:33. TYPE SPECIES: *Pseudouranotaenia rowlandi* Theobald, by monotypy.

Uranotaenia (*Uranotaenia*) *sapphirina* (Osten-Sacken)

Aedes sapphirina Osten-Sacken, 1868. Trans. Am. Entomol. Soc. 2:47. Type-loc.: Washington, District of Columbia and Brooklyn, New York, United States.

Uranotaenia coquilletti Dyar and Knab, 1906c. J. N.Y. Entomol. Soc. 14:187. Type-loc.: United States.

DIAGNOSIS

FEMALE (figs. 189, 190) — *SIZE*: Very small. *HEAD*: Proboscis dark-scaled, sometimes with a few iridescent blue scales; occiput with dark scales, lined laterally with broad, iridescent blue scales, vertex with a patch of iridescent blue-scales; torus naked. *THORAX*: Mesonotum clothed with narrow, golden to light brown scales, with a median line of iridescent blue scales extending to scutellum; lateral margin of mesonotum with a similar line of iridescent blue scales and sides of thorax with small patches of iridescent scales; postspiracular setae absent. *ABDOMEN*: Terga clothed with dark brown, somewhat metallic scales; apices of some terga with a rounded patch of pale scales; eighth segment blunt. *LEG*: Dark except for small patches of pale scales at apices of femur and tibia. *WING*: Length 2.0-2.5 mm; cell R_2 much shorter than vein R_{2+3}; some veins with a few iridescent blue scales.

MALE TERMINALIA (fig. 198) — Structures which may or may not be true *lobes of tergum IX* large, quadrate. *Tergum X* vestigial, not supporting anal membrane. *Phallosome* composed of 2 heavily sclerotized plates, each pointed apically, with a large, subapical, thorn-like projection and 6-7 thorn-like projections in a curved row near base. *Claspette* absent. *Gonocoxite* nearly as wide as long, with many long setae; *basal mesal lobe* with 2-3 long, heavy setae and several finer setae; *apicodorsal lobe* absent. *Gonostylus* about 0.75 times length of gonocoxite, with a patch of several very short setae near apex; *claw* short, peg-like, inserted before apex.

FOURTH INSTAR LARVA (figs. 187, 188) — *HEAD*: Longer than wide; antenna about 0.25 times length of head, dark; seta 1-A small, single, inserted before middle of antenna shaft; head hair 4 double; hairs 5 and 6 single, dark, very stout, spiculate, about as long as antenna. *THORAX*: Prothoracic hairs 1 and 2 long, single; hair 3 with 6-10 branches, less than 0.5 times length of hairs 1 and 2. *ABDOMEN*: Comb with 6-10 scales along distal edge of a sclerotized plate, each scale thorn-shaped with many small lateral spinules. *SIPHON*: Siphon index 3.5-4.5; pecten with 10-15 teeth evenly spaced before middle of siphon, each tooth fringed with many small lateral spinules; seta 1-S multiple, inserted near end of pecten or beyond. *SEGMENT X*: Completely ringed by saddle; apical margin with a row of small spines; seta 1-X a multiple tuft, shorter than saddle; anal papillae approximately length of saddle, pointed.

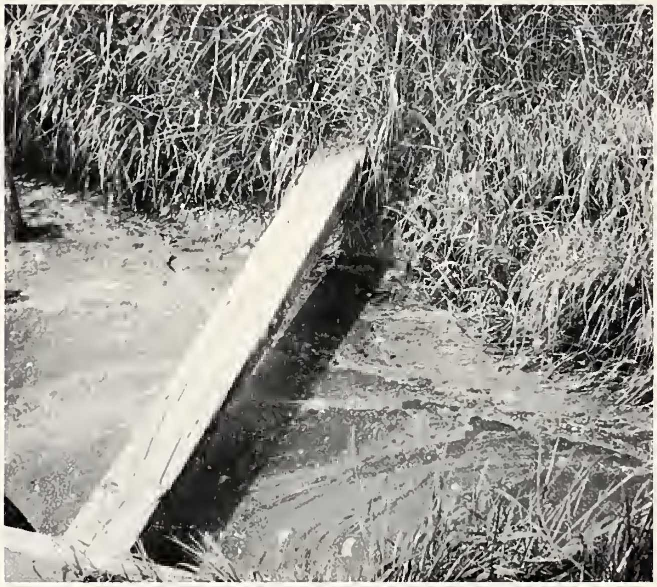

Figure 30. A weed-covered, sunlit pool is a typical habitat for *Uranotaenia sapphirina*, *Culex territans* and *Anopheles* species.

BIONOMICS

Inseminated females of *Uranotaenia sapphirina*, often referred to as the "sapphire-lined" mosquito, overwinter in caves, wells, uninhabited structures and, most often, in hollow trees, especially in cavities having small external openings (Hinman, 1935; Horsfall, 1955; Lawlor, 1935; Peterson and Smith, 1945; Siverly, 1972). Egg rafts containing 50-80 eggs are deposited on the water surface of permanent or semi-permanent ponds (Horsfall, 1955; Mullen, 1970), or in sphagnum bogs (Owen, 1937) beginning in late spring. The rafts are irregular, lacking the lineal uniformity of rafts of *Culex* and *Coquillettidia*. They float partially submerged, rather than on the surface as do the rafts of the latter genera (Mullen, 1970).

Larvae are most frequently found in permanent or semipermanent ponds lying parallel to the surface, much the same as *Anopheles* species larvae, among the leaves and stems of floating vegetation such as pondweed (*Potomogeton* species) and duckweed (*Lemna* species). Since these leaves are usually tiny and extremely abundant, larvae of *Ur. sapphirina* are often difficult to detect and to collect. In Suffolk County, larvae have often been collected in open sphagnum bogs around the trunks of trees and also in cavities beneath blankets of moss. *Uranotaenia sapphirina* has multiple, continuous generations from spring until frost (Horsfall, 1955), but larvae are not usually found in New York until July and are most abundant in late summer.

New York species with which the larvae of *Ur. sapphirina* are most often associated include *Anopheles quadrimaculatus, An. walkeri, An. punctipennis, An. crucians, Culex territans, Cx. restuans, Cx. salinarius* and *Coquillettidia perturbans* (Dorsey, 1944; Horsfall, 1955; Mullen, 1970; Owen, 1937; Siverly, 1972). The author has most often collected *Ur. sapphirina* larvae in association with *An. punctipennis, Cx. territans* and *Cx. restuans*. In Suffolk County it has often been collected with *Culiseta melanura* in sphagnum bogs.

Adults rest during the day in dark cavities such as culverts, caves and hollow trees, and are most active in early evening. They are readily attracted to light and are sometimes collected in large numbers at light traps (Barr, 1958; Carpenter and LaCasse, 1955; Siverly, 1972). Pratt (1946) suggested that *Ur. sapphirina* probably has a flight range of a half a mile or less; however, MacCreary and Stearns (1937) collected females in light traps 8.8 km from the nearest land in Delaware Bay.

Rozeboom (1942) reported *Ur. sapphirina* as biting man and horses, but other workers have reported this species bites man rarely, if at all, and its preferred hosts are unknown. The author has never observed *Ur. sapphirina* to be attracted to man, even in places where females were known to be abundant. *Uranotaenia lowii*, a species which occurs in the southern United States, has been found to feed on amphibians, but not reptiles or mammals (Remington, 1945).

DISTRIBUTION

Uranotaenia sapphirina is distributed throughout the eastern and central United States west to North Dakota, New Mexico and Nevada, southern Canada, and New Mexico (Knight and Stone, 1977). It has been collected from several areas of New York State at elevations below 2000 feet, especially in the lower Hudson River Valley and on Long Island, near sea level. Barnes et al. (1950) reported this species to be "fairly common" in the State. It probably occurs throughout the lowland areas of the State, although the author has collected it from only a few localities.

IMPORTANCE

Because the female of *Uranotaenia sapphirina* rarely, if ever, bites man, this species, like others in the genus, is of no medical or economic importance.

SUBFAMILY TOXORHYNCHITINAE

The subfamily Toxorhynchitinae contains a single genus, *Toxorhynchites*, with 71 recognized species and subspecies, most of which are limited to tropical regions of the world (Knight, 1978; Knight and Stone, 1977; Ward, 1984).

Because the larvae of this genus prey on other larvae, they have been investigated for possible use in biological control of mosquitoes. Some of this work has been summarized by Hemmerlein and Crans (1968). The reader is also referred to Focks et al. (1983a,b) and Schuler and Beier (1983) for references relating to recent studies on the use of *Toxorhynchites* species in biological control. Adults of this genus are very large, diurnal and nonbloodsucking. Most are brilliantly colored, including the two subspecies of *Tx. rutilus*, the only representatives of the genus in North America.

Genus *Toxorhynchites* Theobald

Toxorhynchites Theobald, 1901b. J. Trop. Med. 4:234; Mon. Cul. 1:244. TYPE SPECIES: *Toxorhynchites brevipalpus* Theobald, 1901, by monotypy (Int. Comm. Zool. Nomencl., 1959, opinion 548).

Worcesteria Banks, 1906. Philipp. J. Sci. 1:779. TYPE SPECIES: *Worcesteria grata* Banks, by original designation.

Teromyia Leicester, 1908. Stud. Inst. Med. Res. F. 3(3):49. TYPE SPECIES: *Teromyia acudata*, by subsequent designation (Brunetti, 1914:72).

Subgenus *Lynchiella* Lahille

Megarhinus Robineau-Desvoidy, 1827. Mem. Soc. Hist. Nat. Paris 3:412. TYPE SPECIES: *Culex haemorroidalis* Fabricius, 1787, by monotypy [preoccupied (Stone, 1948)].

Lynchiella Lahille, 1904. Act. Congr. Med. Lat. Am. 2:14. TYPE SPECIES: *Culex haemorroidalis* Fabricius, by autonymy.

Toxorhynchites (*Lynchiella*) *rutilus septentrionalis* (Dyar and Knab)

Megarhinus septentrionalis Dyar and Knab, 1906b. Smithsonian Misc. Coll. 48:249. Type-loc.: Woodstock, Virginia.

Megarhinus herrickii Theobald, 1906. Entomologist 39:241. Type-loc.: Mississippi.

Toxorhynchites rutilus septentrionalis, Jenkins and Carpenter, 1946. Ecol. Monogr. 16:43 (to subspecific status).

IMPORTANT REFERENCE: Hemmerlein and Crans, 1968 (bionomics).

DIAGNOSIS

FEMALE (figs. 193, 194, 196) — This large species has a metallic blue iridescence over most of its body. *SIZE*: Very large. *HEAD*: Proboscis long, strongly curved downward, clothed with iridescent blue scales; maxillary palpus massive, about 0.66 length of proboscis, iridescent blue-scaled except with metallic golden scales laterally; occiput with flat, appressed iridescent blue scales dorsally, golden yellow scales laterally and around eye margins; torus black with gray pubescence. *THORAX*: Mesonotum dark brown, clothed with dark purplish-brown scales except for a broad median stripe and lateral margins of golden yellow scales having a metallic blue iridescence; pleura with broad patches of flat silvery scales; scutellum with dark brown scales centrally, golden yellow scales on the lateral and posterior margins, all with a metallic blue iridescence. *ABDOMEN*: Terga uniformly clothed with dark brown scales having a metallic blue iridescence. *LEG*: Dark brown-scaled with a purplish reflection; tarsal segments mostly white-scaled; white knee spots present. *WING*: Length 6.0-7.0 mm; anterior veins sparsely scaled with dark brown-metallic blue scales.

MALE TERMINALIA (fig. 195) — *Lobes of tergum IX* widely separated, with several long setae. *Tergum X* heavily sclerotized apically, with a heavy, outwardly projecting apical tooth. *Anal lobe* with 4-5 short, fine teeth at each outer corner where supported by tergum X. *Phallosome* bottle-shaped; 2 lateral sclerotized plates connected dorsally near base by a narrow bridge; pointed apically, with several ventrally-directed teeth along each outer edge of narrow distal portion. *Claspette* absent. *Gonocoxite* about twice as long as wide, with many long and short setae and scales; *basal mesal lobe*, rounded, with 3-4 long, heavy setae and several shorter, finer setae; apicodorsal lobe absent. *Gonostylus* about as long as gonocoxite, with many small setae on distal half; claw slender, inserted at apex.

FOURTH INSTAR LARVA (figs. 191, 192) — *HEAD*: About as long as broad; antenna about 0.3 times length of head, smooth; seta 1-A short, multiple, inserted on outer fourth of antenna shaft, preceded by a single hair; mouth brushes consisting of about 10 prehensile, smooth, curved rods; head hairs 5-7 single, subequal and moderate in length; hair short, multiple. *THORAX*: Many of the hairs modified into stout spines, several of these spines and normal hairs arising from sclerotized bases or tubercles. *ABDOMEN*: Segment VIII with a large sclerotized plate bearing 2 long, barbed spines and 2 short, multiple hairs on posterior margin. *SIPHON*: Siphon index 1.5-2.0; pecten absent; seta 1-S multiple, barbed, about as long as width of siphon, inserted near base. *SEGMENT X*: Saddle complete, fringed on posterior margin with long and short spines; seta 1-X a stout, barbed spine, nearly length of saddle, inserted on distal margin; dorsal brush with a lower caudal tuft of 4-5 subequal branches and an upper tuft of 8-10 subequal branches; each hair of ventral brush dendritic or feathered; anal papillae rounded, much shorter than saddle.

BIONOMICS

The immature stages of *Toxorhynchites rutilus septentrionalis* normally occur in rot holes of deciduous trees (Jenkins and Carpenter, 1946). They are also found in similar shaded cavities, especially those lined with wood or containing leaves (Hemmerlein and Crans, 1968; Horsfall, 1955; Jenkins and Carpenter, 1946). Howard et al. (1917) reported finding larvae in a rock pool associated with *Aedes atropalpus*, and Hemmerlein and Crans (1968) frequently found them in discarded tires in New Jersey.

Eggs are deposited singly on the water surface as the female circles several inches above the oviposition site (Hemmerlein and Crans, 1968). Normally 4 to 12 eggs are deposited at a single oviposition attempt (Williams et al., 1961), but as many as 18 have been found in a single tree hole (Michener, 1947). Larvae are predacious upon mosquito larvae and other aquatic insects. Lake (1954) observed that approximately 100 mosquito larvae were consumed during the normal larval life of *Tx. rutilus septentrionalis*. Although other species of *Toxorhynchites* are known or suspected to be cannibalistic and some species compulsively kill all other mosquito larvae before pupating in order to protect themselves, several larve of *Tx. rutilus* have often been kept in close quarters for long periods without excessive cannibalism being observed (Jenkins and Carpenter, 1946; Hemmerlein and Crans, 1968).

The time required for development varies from as few as 25 days to several months from egg to adult, depending on diet and temperature (Breland, 1949; Dodge, 1964; Hemmerlein and Crans, 1968; Jenkins and Carpenter, 1946; Morgan and Cotton, 1908). Mature larvae enter diapause for overwintering with the onset of cold weather in late fall. These larvae may be found during the winter by breaking ice covered water in the tree holes (Hemmerlein and Crans, 1968; Lake, 1954). The pupal period normally lasts 4-7 days, but may be extended to about 3 weeks with a lowering of temperature. There are apparently several overlapping generations a year, at least in the southern portion of its range (Jenkins and Carpenter, 1946; Horsfall, 1955). At the northern limit of its range, in New Jersey, larvae of *Tx. rutilus septentrionalis* are rare but have been found in association with *Anopheles barberi*, *Orthopodomyia alba*, *Or. signifera* and *Aedes triseriatus* (Lake, 1954).

Adults of *Toxorhynchites* are incapable of taking a blood meal, but have been observed feeding on nectar of several plants (Knab, 1911; King et al., 1942; Jenkins and Carpenter, 1946). They are sylvan, only rarely found out of the deep woods or very far from their breeding places.

DISTRIBUTION

Toxorhynchites rutilus septentrionalis is distributed throughout the southeastern United States as far north as New Jersey, west to Kansas and Texas, with one Canadian record from southern Ontario (Parker, 1977). Larvae have been collected occasionally from Connecticut (Main et al., 1976) and from New York State, from a sweet gum tree in New York City (Klots, 1961), from "Pine Brook," probably in Tompkins County (Cornell Univ. Coll.), from Nassau County (W. G. McClure, pers. comm.), and from tires in Manorville, Suffolk County (Guirgis and Van Ostrand, 1976).

IMPORTANCE

The adults of *Toxorhynchites* do not take blood, and therefore are of no medical importance. Attempts have been made to utilize larvae of some species of this genus to reduce populations of pest mosquitoes through predation. Such experiments have been largely unsuccessful, partly due to the cannibalistic tendencies of the species tested. However, since cannibalism is less common in *Tx. rutilus* than in other species, Hemmerlein and Crans (1968) expressed the opinion that this species might be found more useful for this purpose.

Biological control of pest species using *Tx. rutilus* is probably not feasible in New York State since this is beyond the normal range of the species.

CONTROL OF MOSQUITOES

It is often necessary to attempt to exterminate, or at least reduce, mosquito populations, especially when they are medically or economically important as vectors or potential vectors of disease organisms to humans or domestic animals. It is also often desirable to reduce populations of nuisance species which may be important because of their annoyance. In most cases there is no need to attempt control of mosquito species which are not attracted to humans and do not transmit disease organisms to domestic animals. Some such species, however, act as vectors to maintain disease organisms in wild animal reservoirs. By reducing or eliminating these mosquito vectors the incidence of infection in domestic animals or humans may be diminished.

There are several possible methods for reducing mosquito populations, including mechanical control by altering the breeding habitat, chemical control of larvae or adults using insecticides, and biological control using natural parasites or predators. Many mosquito control programs employ a combination of at least mechanical and chemical control. There have been numerous recent advances in biological control of mosquitoes which have shown promise as a viable method of reducing certain types of mosquitoes, with less potential danger to non-target organisms than with chemical control.

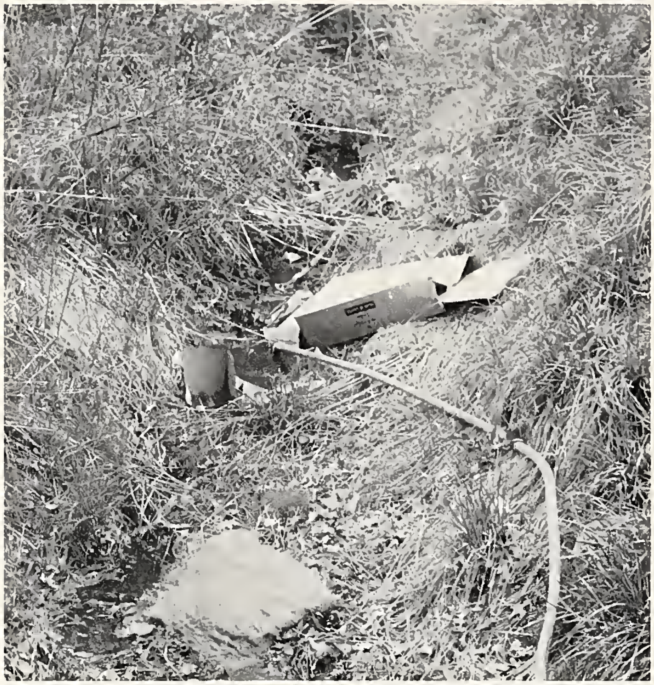

Figure 31. Inadequate landscaping and poor maintenance behind shopping centers frequently create standing water conducive to mosquito breeding.

Federal and state regulations on use of insecticides for mosquito control change periodically as new information is learned regarding their effect on humans and other non-target organisms. For this reason, specific recommendations are not included in this publication. The reader is referred to the agency in his state which regulates the use of pesticides for control of vectors. In New York State this agency is the Bureau of Vector Control, New York State Health Department, Empire State Plaza, Albany, New York 12237. There may also be regulations on treatment with insecticides of certain types of land. In New York State a permit must be obtained from the New York State Department of Environmental Conservation, Wolf Road, Albany, New York 12233 to treat State-owned lands. Jamnback (1969) has summarized the legal aspects pertaining to control of insect vectors within New York State.

MECHANICAL CONTROL BY ALTERING THE BREEDING HABITAT

Mosquitoes often breed in places where there is standing water due to inadequate drainage for one reason or another. For example, construction sites for housing or business developments are frequently left incompletely graded, causing water-filled depressions, thereby providing breeding habitats for many mosquito species. Culverts which are improperly placed, poorly maintained or damaged, often result in inadequate drainage and subsequent breeding in standing pools of water. Roadside ditches frequently become clogged with debris, overgrown with grass and weeds, or blocked by sand or soil. Standing or slowly moving water resulting from these conditions may breed many mosquito species.

The most effective and least costly means of control in these and similar instances often is to eliminate or alter the breeding habitat. Through annual inspection, maintenance and repair of culverts and cleanup of roadside drainage ditches, much mosquito breeding can be eliminated. Proper cleanup, grading and construction of drainage lines following construction of shopping centers, office complexes or housing developments can eliminate most mosquito problems in such areas.

Some less evident but very productive breeding habitats for several mosquito species include artificial containers, such as discarded tires, buckets, barrels and numerous other items which can usually be easily removed.

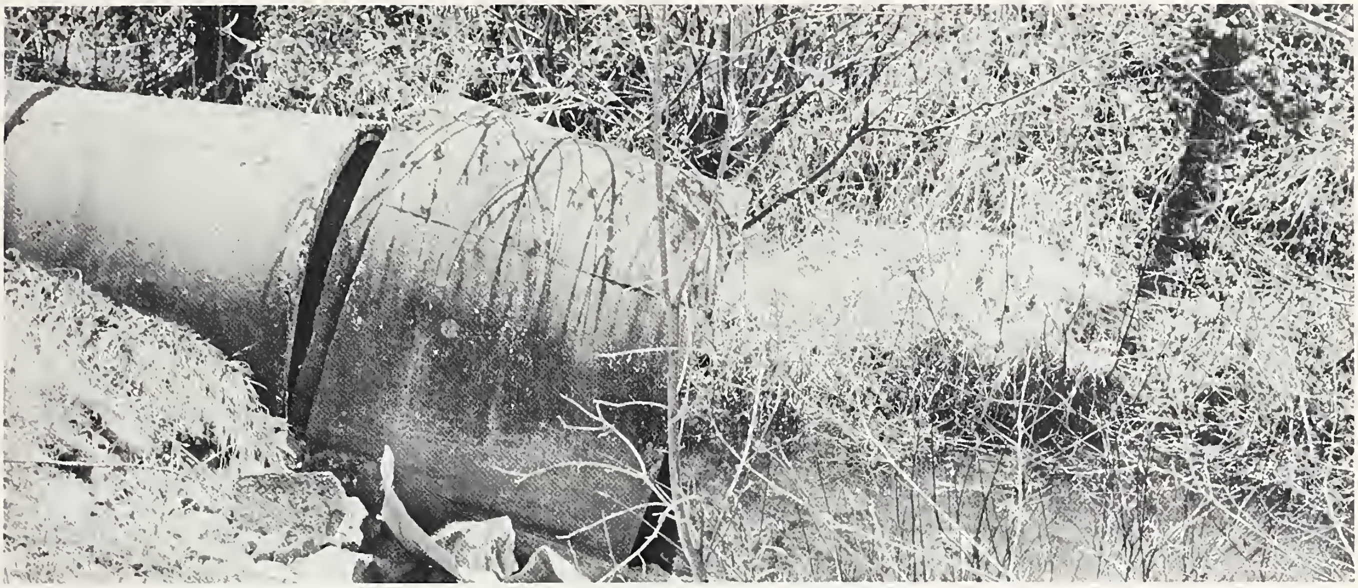

Figure 32. A poorly-maintained culvert may create standing water which promotes mosquito breeding.

Other often overlooked habitats include clogged rain gutters and basement window wells around both private homes and public buildings. By cleaning gutters periodically, and by constructing roofs, or covers over window wells, much breeding can be eliminated. For these and other situations which may be found around households, it is effective and relatively inexpensive for a mosquito control agency to produce and distribute informative brochures, instructing citizens on where mosquitoes may breed and how they, as individuals, can help control them.

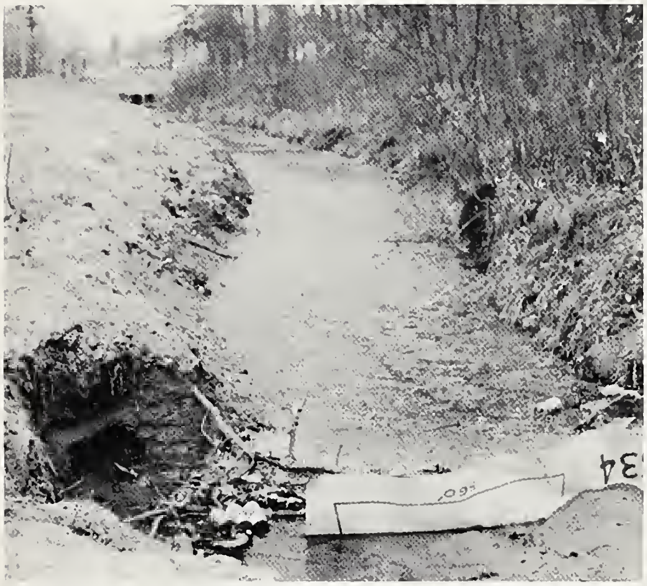

Figure 33. An overgrown or debris-clogged drainage ditch can create stagnant water, conducive to mosquito breeding.

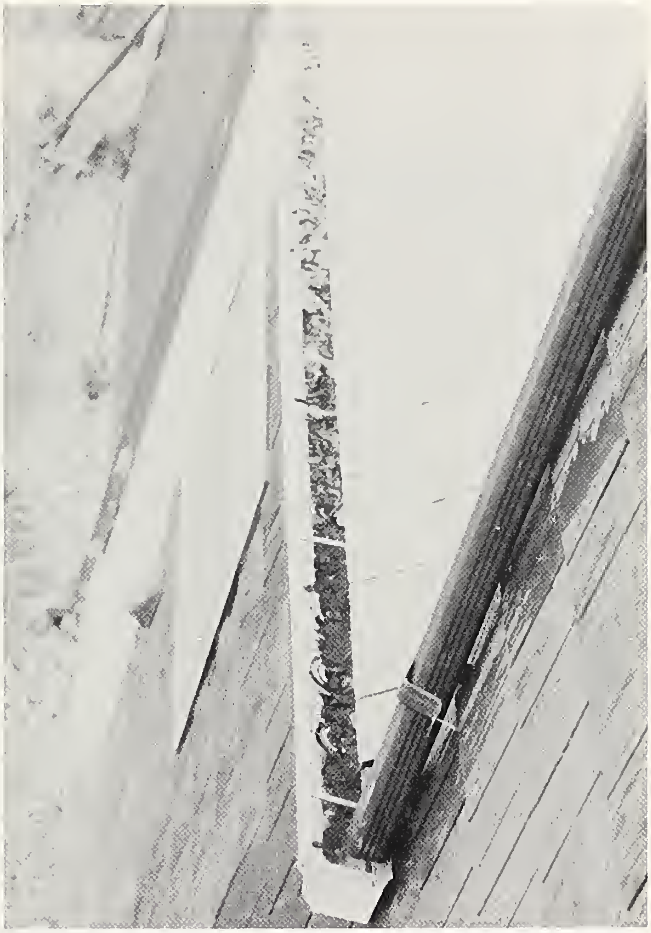

Figure 34. Rain gutters can become blocked with leaves, thereby creating standing water which breeds mosquitoes.

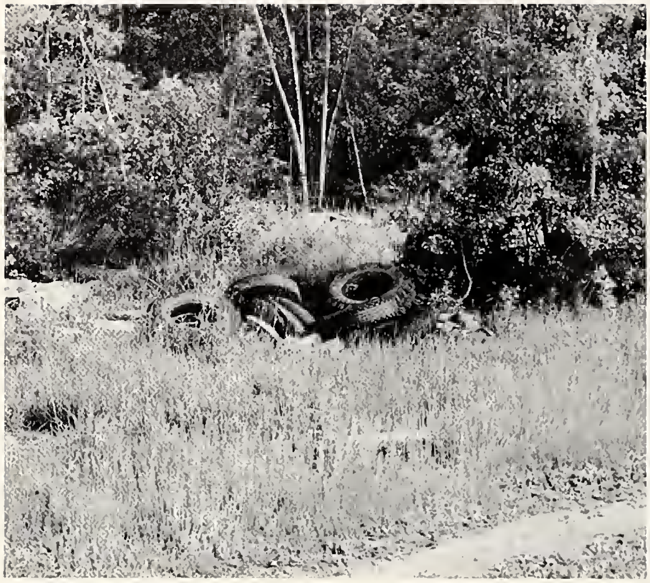

Figure 35. Water-holding containers, such as discarded tires, breed large quantities of mosquitoes.

A classic example of how mechanical altering of habitats can control mosquito breeding is in coastal salt marshes, where numerous pools of standing water, filled by rains and fluctuating tides, provide an ideal habitat for *Aedes sollicitans* and other mosquitoes. Construction of ditches to drain water from these pools, thereby allowing it to ebb and flow with the tide could reduce or eliminate breeding. Occasionally these ditches may become blocked or partially filled in, thereby creating additional mosquito breeding. It is imperative, therefore, to provide periodic inspection and maintenance of these ditches, as is necessary for all drainage ditches.

CHEMICAL CONTROL

Insecticides are used in various formulations and applied by various methods to kill mosquitoes either as larvae or as adults. The formulation and method used is dependent upon many factors. These include the extent of the area to be treated, its location in relation to areas which should not be treated with insecticide, non-target organisms in the area, and extent of the actual or potential threat of disease transmission by mosquitoes in the area.

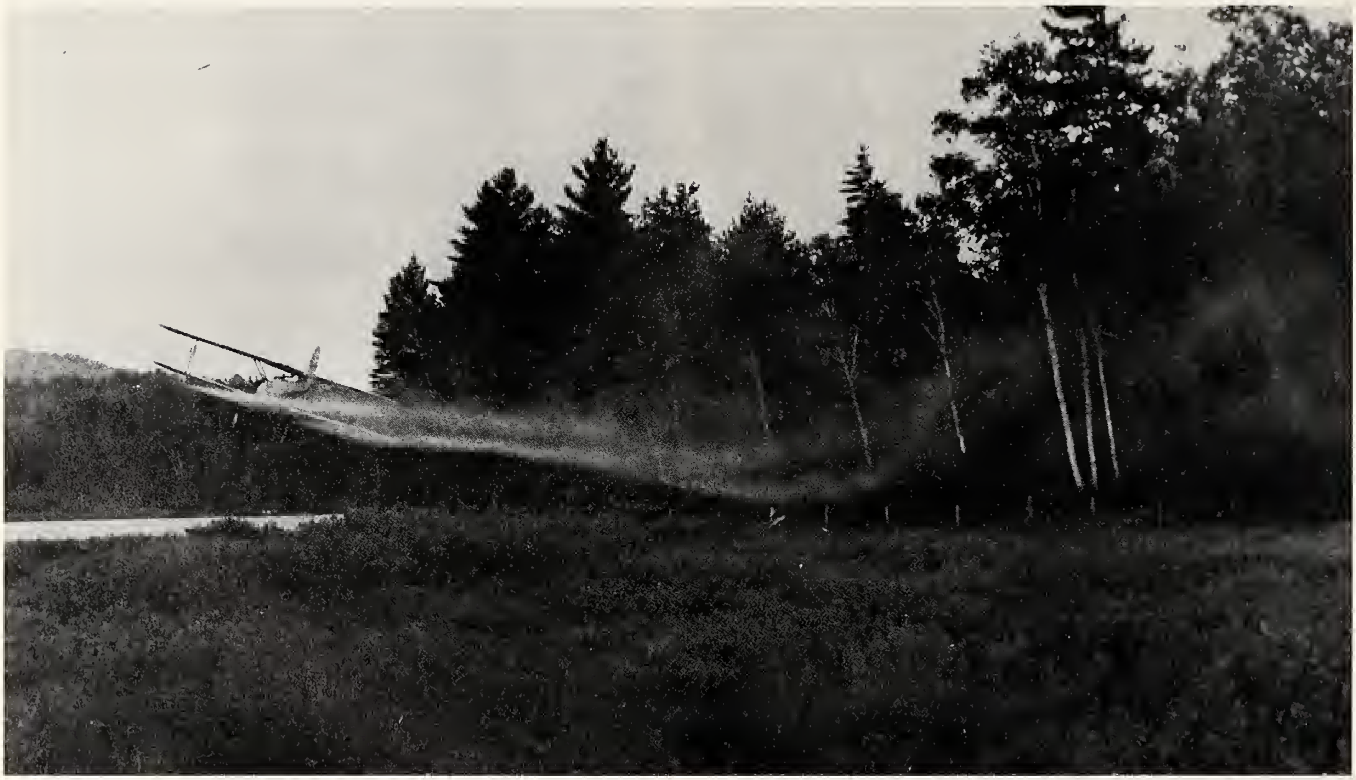

Figure 36. Airplanes are often used to dispense insecticides or biological control agents for mosquito control.

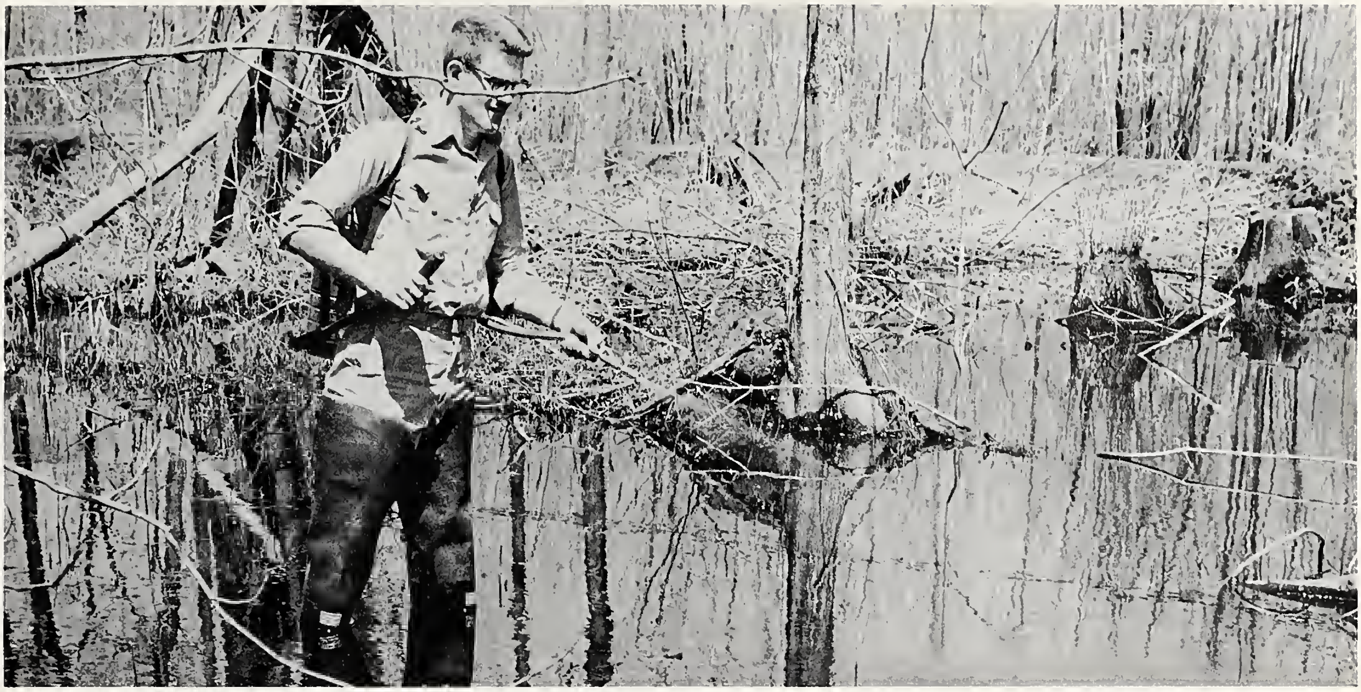

Figure 37. Spraying mosquito larvicide from a backpack sprayer.

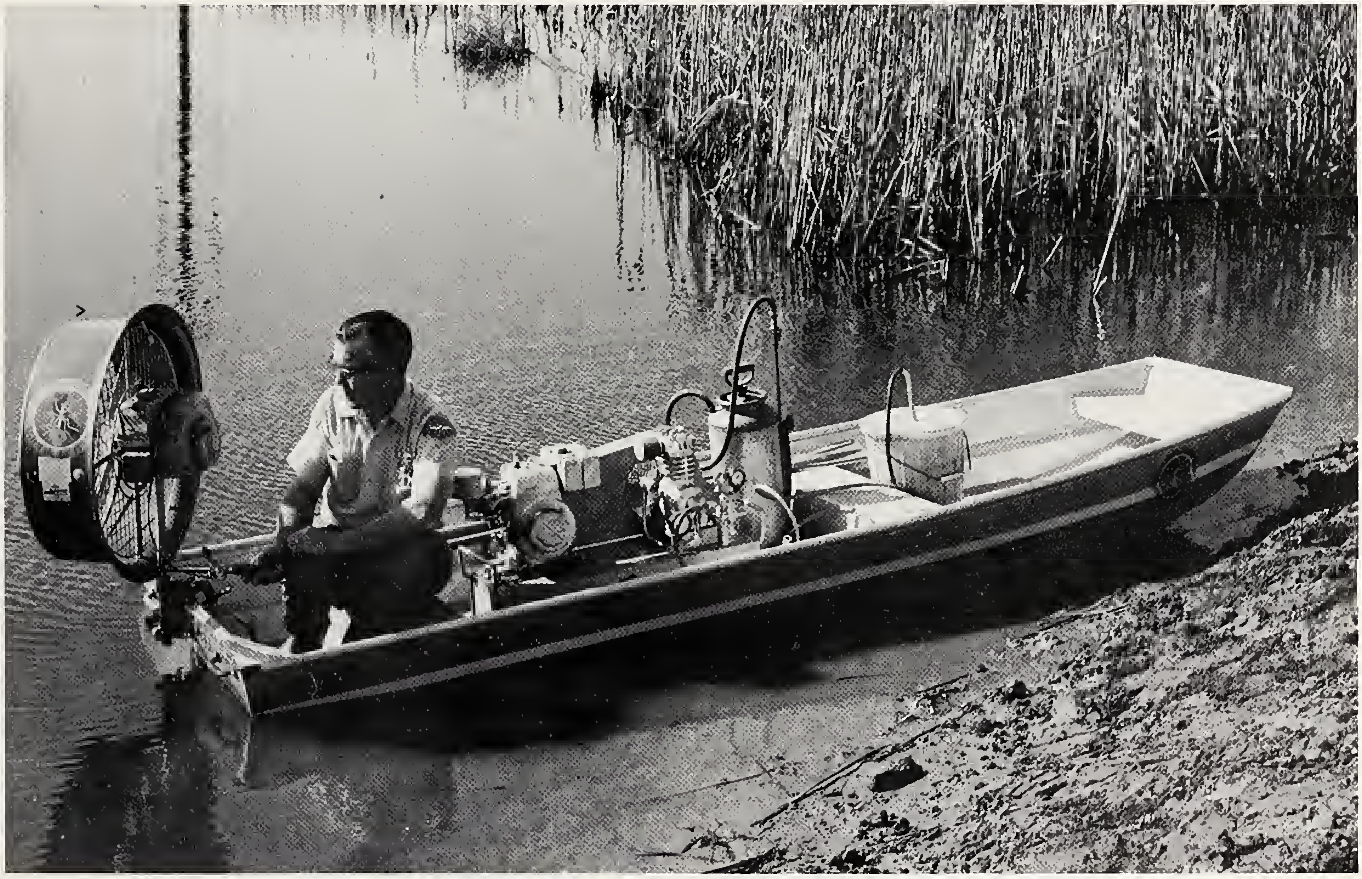

Figure 38. An airboat is sometimes used to dispense insecticide in a marsh.

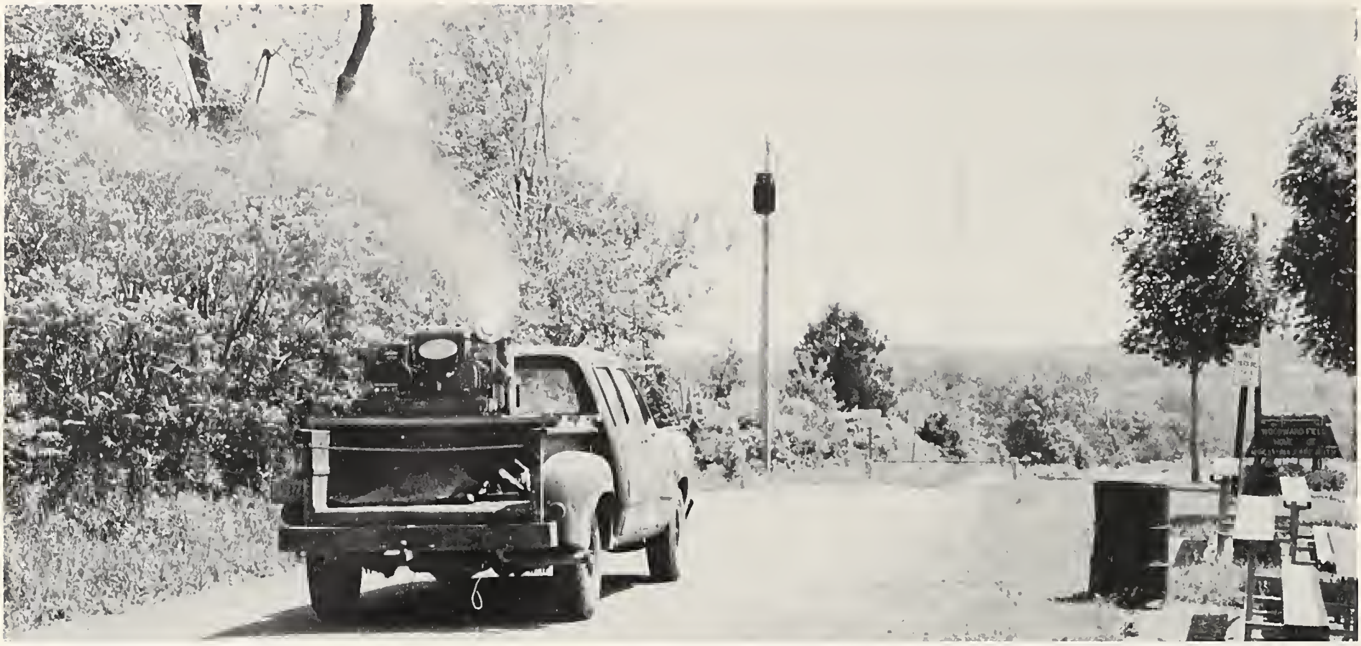

Figure 39. Truck-mounted aerosol foggers are often used by municipalities to reduce adult mosquito populations.

Formulations normally employed include oil solution containing insecticide, which can sink or float as desired by varying the type of petroleum product used as a carrier; emulsifiable concentrate, which is oil solution with emulsifier added to allow dilution with water; wettable powder, which forms a suspension with water; or granules of clay, sand, corncob grit or other material, treated with insecticide. The latter formulation is heavy enough to pass through foliage to the water below, where release of the insecticide from the granules can be designed to occur over an extended period, or at a particular temperature, if desired. One of the most commonly used formulations for mosquito control in recent years is undiluted insecticide applied in small dosages, using a superfine spray (ultra-low volume technique).

Insecticides for larval control can be applied to large areas by air, either helicopter or fixed wing aircraft, or by hand sprayer for small, localized breeding. Specific circumstances may determine the manner in which a sprayer is transported, e.g. backpack, airboat, trunk, motorcycle, etc.

Adult mosquitoes can be controlled to some extent, sometimes quite effectively, by applying insecticide in a fine spray, mist or fog, either by air or ground equipment (figs.). These methods are used extensively to reduce adult mosquito populations when the danger of disease transmission has been demonstrated and immediate control is needed.

BIOLOGICAL CONTROL

Jamnback (1969) presented a brief review of the studies involving biological control methods against insects of medical importance. He noted that, although biological control had been used successfully against insects attacking agricultural crops, there had been relatively little funding available for studies on biological control of medically important insects. There were, however, many possible agents for control of blackflies and mosquitoes that should be investigated, and he felt that in the long run they may prove more effective than insecticides for control.

Since that time there has been increasing concern over the dangers of contaminating water supplies, of leaching in soil, and of direct human contact by chemicals, including those used for control of non-agricultural insects. Although chemical insecticides are still the primary method of controlling medically important insects such as mosquitoes, there has been considerable research on the use of various microbial agents, and biological control is coming closer to becoming a practical reality. One bacterium, *Bacillus thuringiensis* var. *israelensis*, is now commercially available and is being widely tested and used in the field for control of mosquito and blackfly larvae. Several other species of bacteria, fungi, protozoa and nematodes have been found effective under certain conditions and are nearly ready for field testing. Davidson and Sweeney (1983) have recently reviewed the progress of studies directed at microbial control of vectors, especially mosquitoes. The reader is referred to this excellent review for a comprehensive bibliography of recent accomplishments and discoveries in this method of control.

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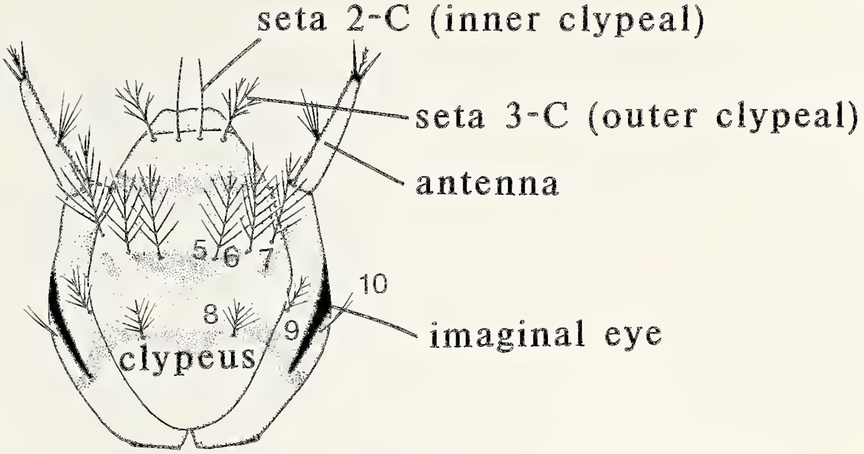
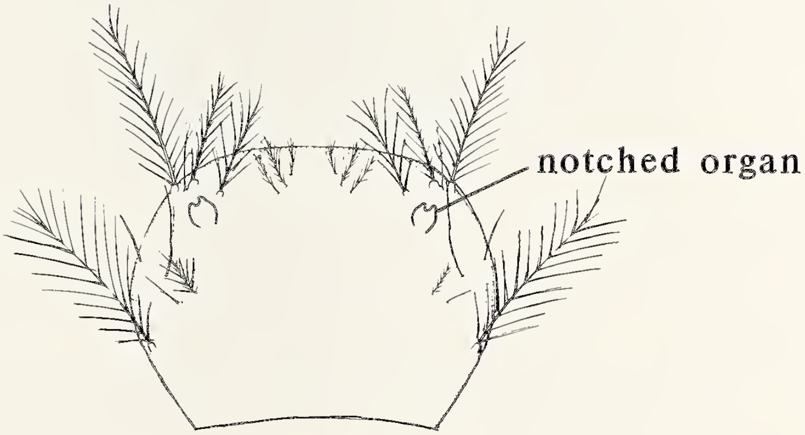
PLATE I	**Fourth instar anopheline mosquito larva**
Figure 40	***Anopheles quadrimaculatus***

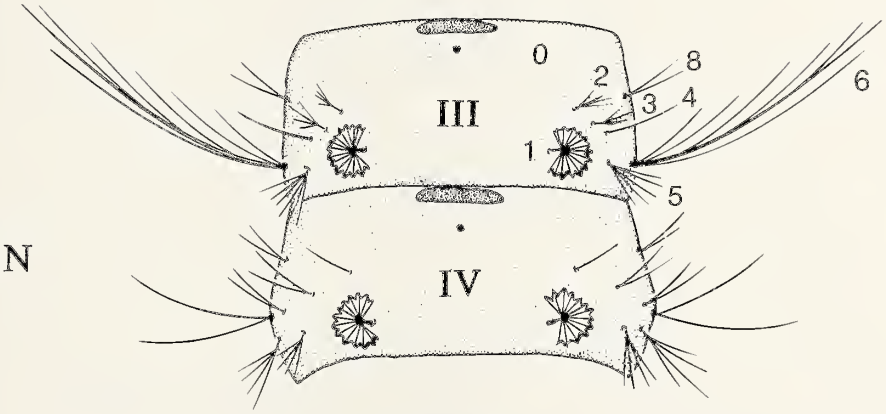
HEAD



THORAX



ABDOMEN



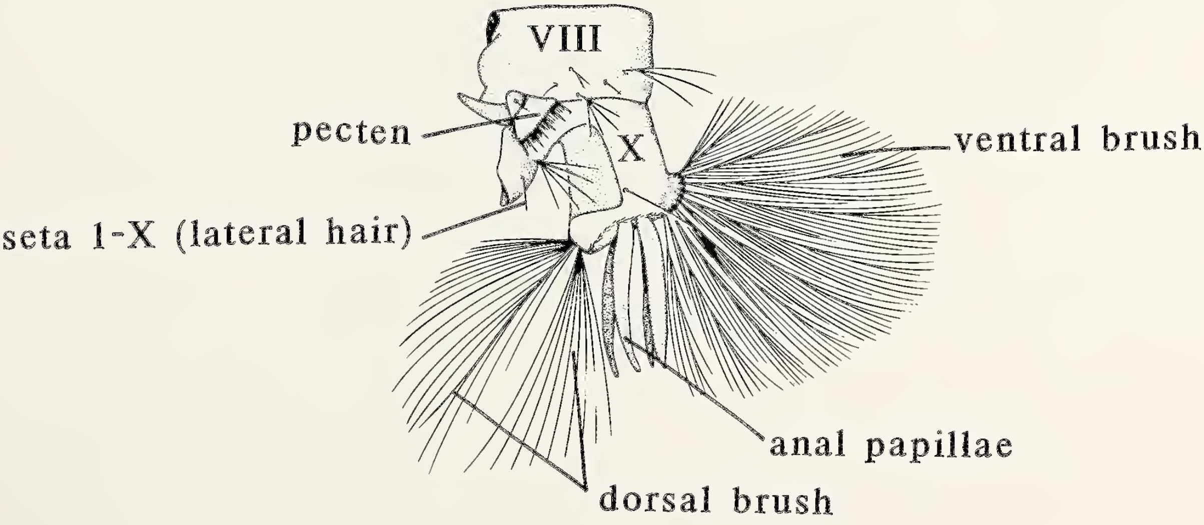
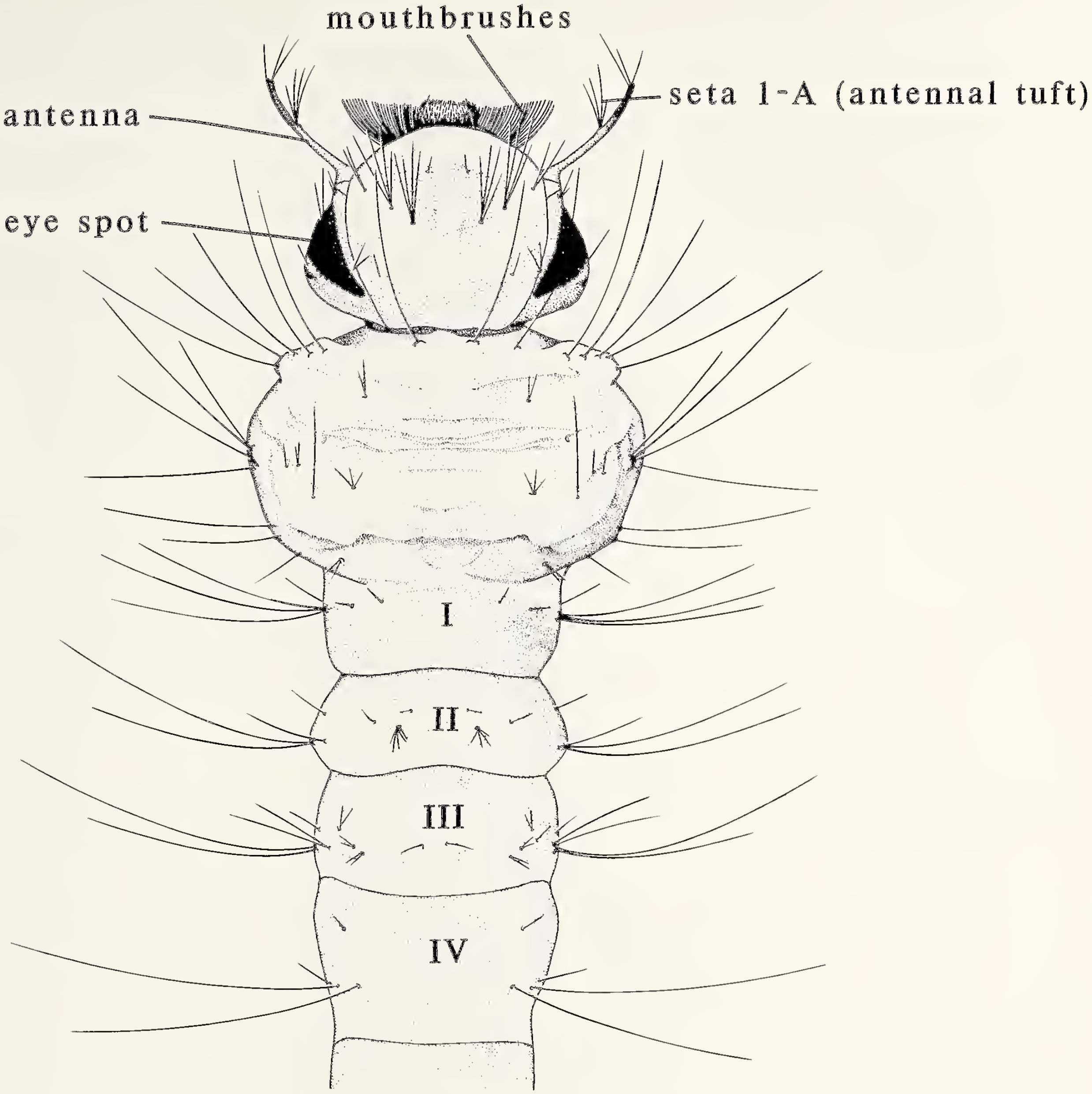


PLATE II	**Fourth instar culicine mosquito larva**
Figure 41	***Culex restuans***


mouthbrushes
antenna
seta 1-A (antennal tuft)
eye spot
I
II
III
IV

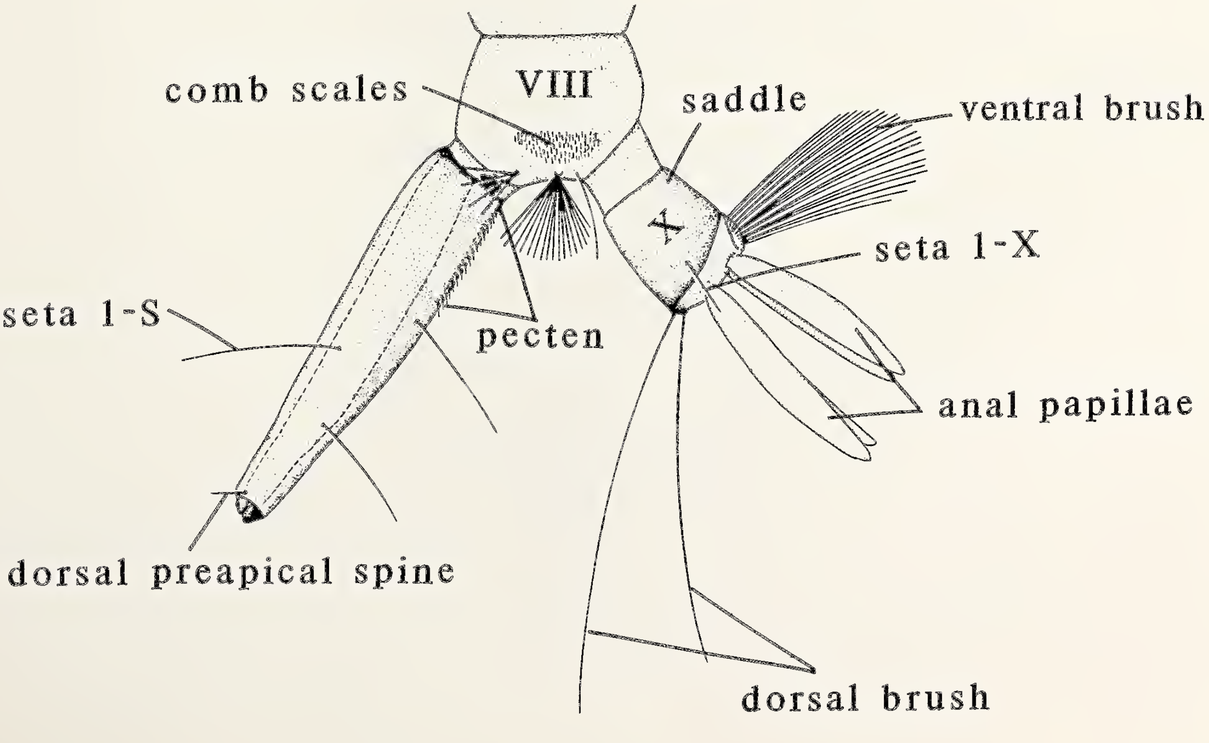

VIII
comb scales
saddle
ventral brush
X
seta 1-X
seta 1-S
pecten
anal papillae
dorsal preapical spine
dorsal brush

PLATE III	**Mosquito pupa**
Figure 42	***Psorophora ciliata***

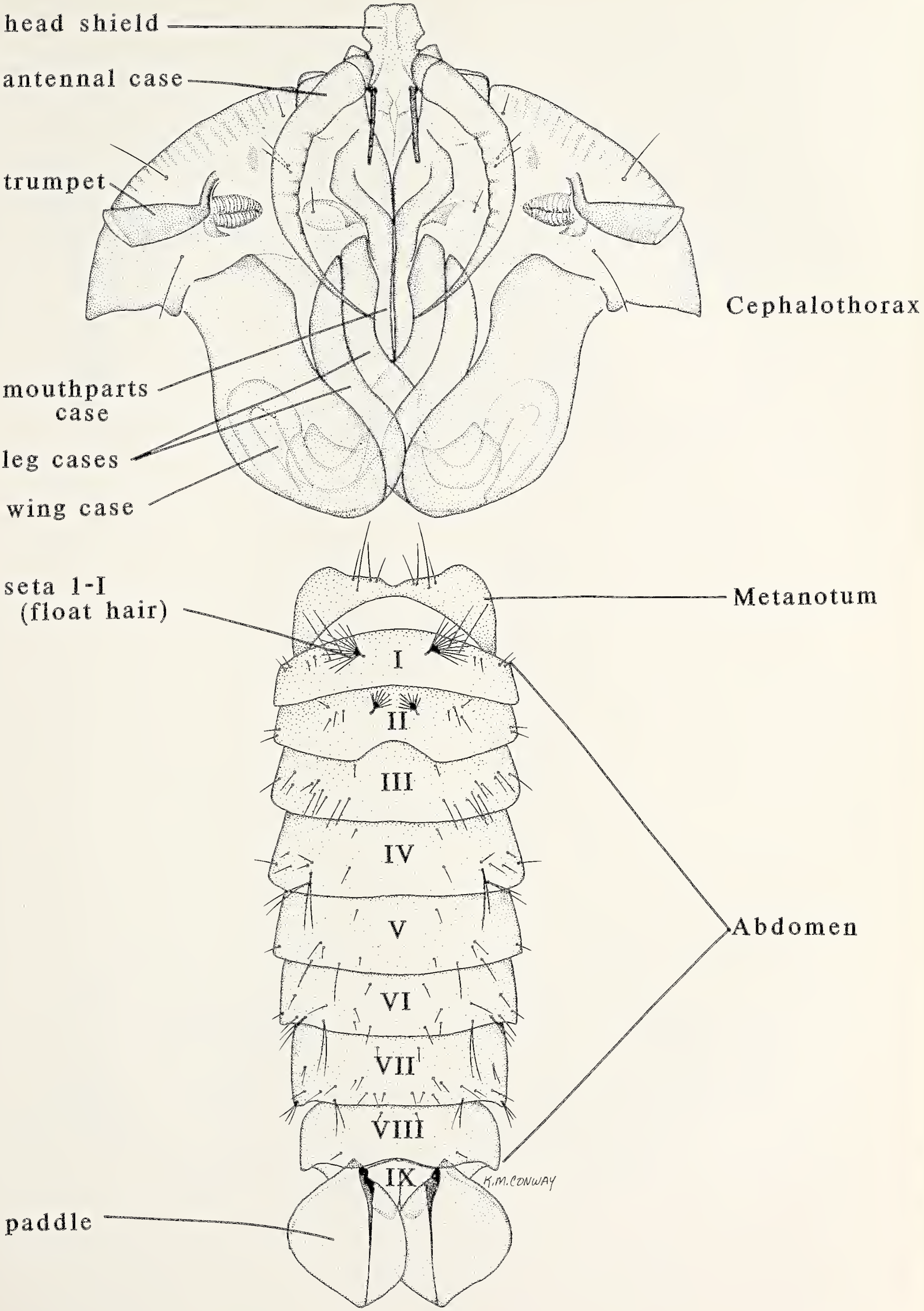
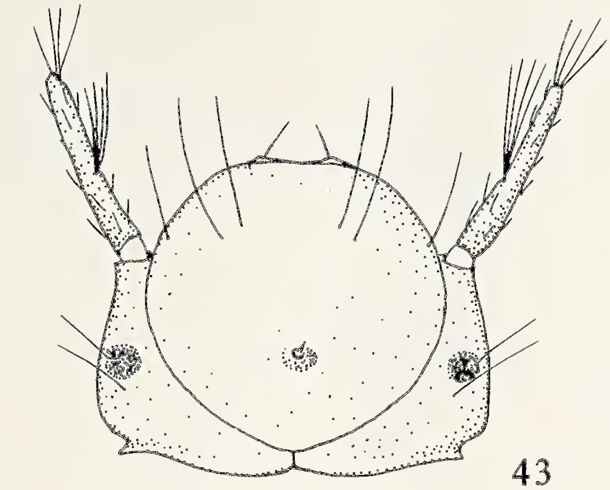
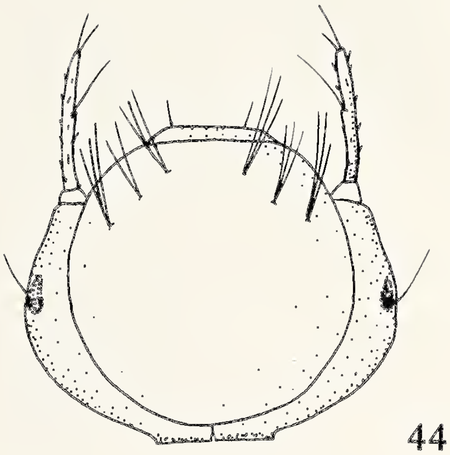

head shield
antennal case
trumpet
Cephalothorax
mouthparts case
leg cases
wing case
seta 1-I (float hair)
Metanotum
I
II
III
IV
V
VI
VII
VIII
IX
Abdomen
K.M.CONWAY
paddle

PLATE IV	Culicine larva, *Culex restuans*
Figure 43	First instar, head
44	Second instar, head
45	Third instar, head
46	Second instar, metathorax, lateral aspect
47	Third instar, metathorax, lateral aspect



43



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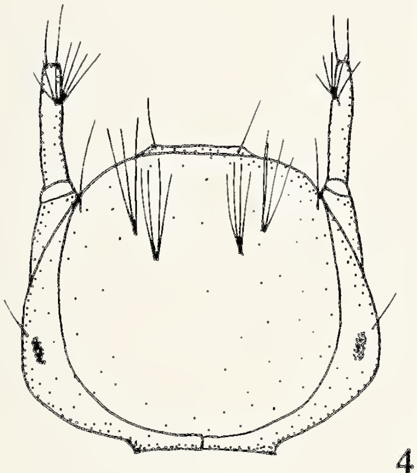

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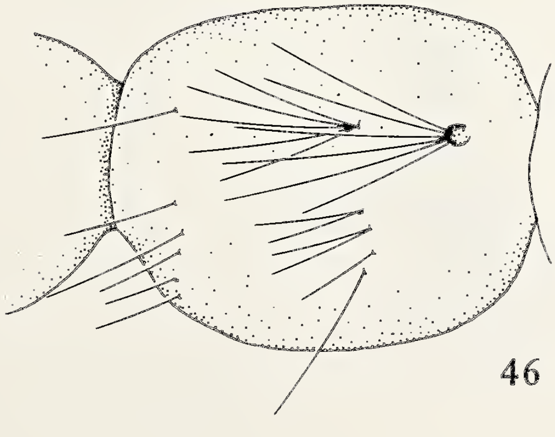

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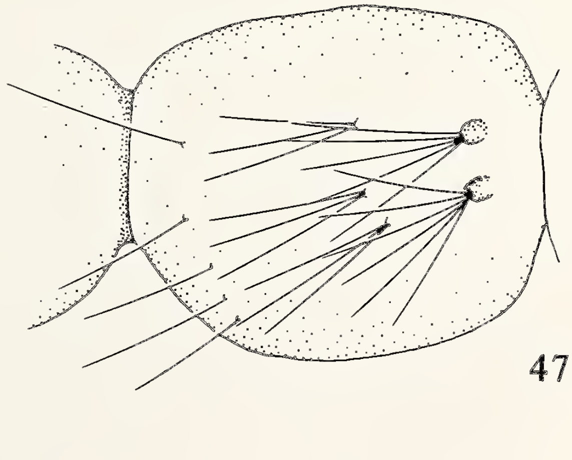
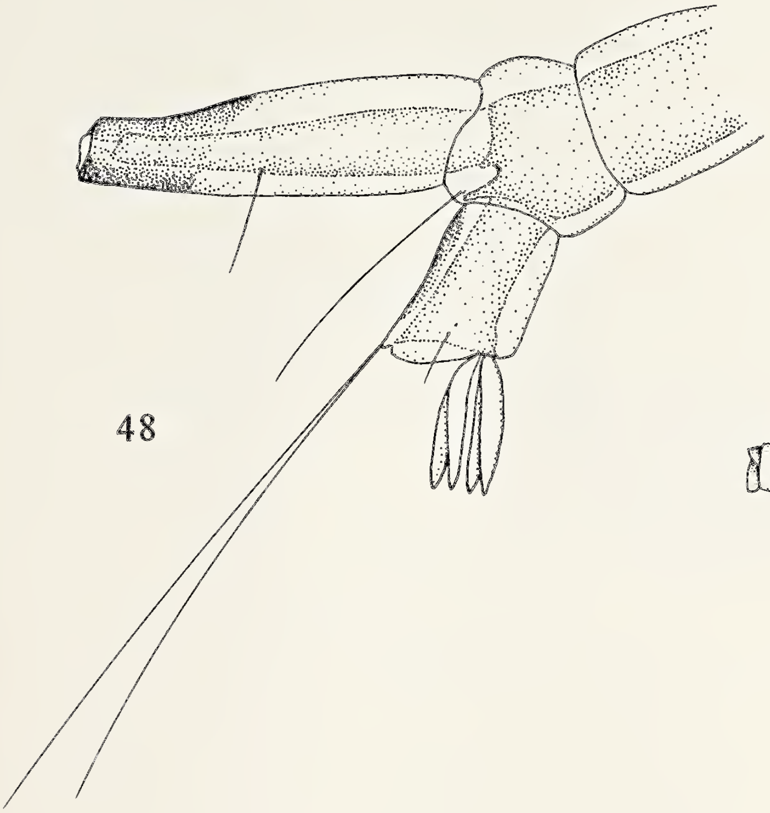


47

PLATE V	Culicine larva, *Culex restuans*, terminal segments
Figure 48	First instar
49	Second instar
50	Third instar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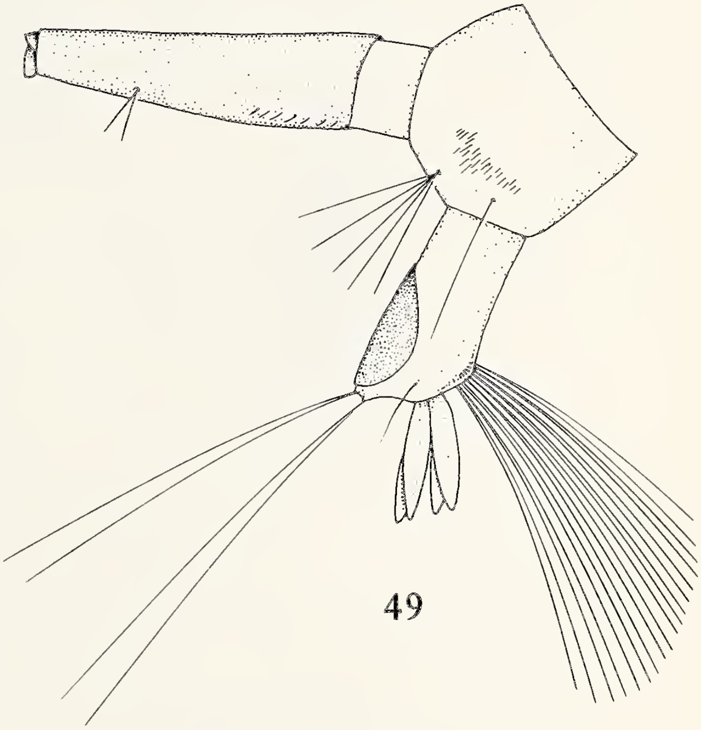
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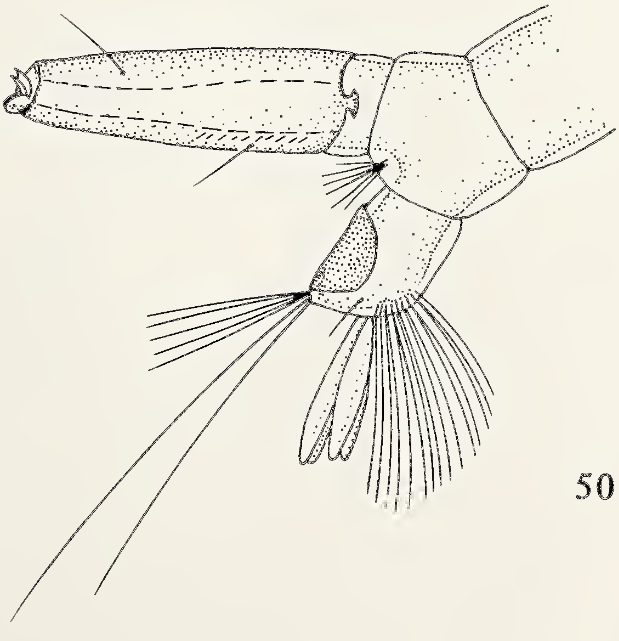
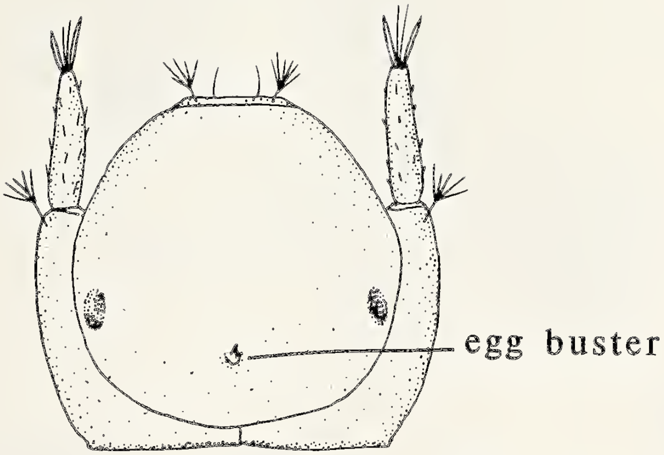

50

PLATE VI	**Anopheline larva, *Anopheles punctipennis***
Figure 51	**First instar, head**
52	**First instar, terminal segments**
53	**Second instar, head**
54	**Third instar, head**



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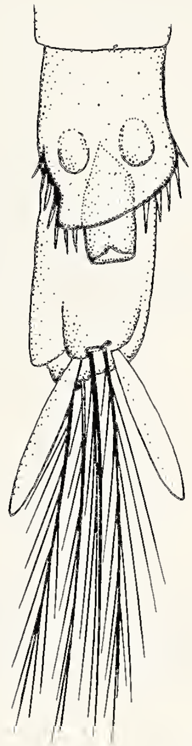

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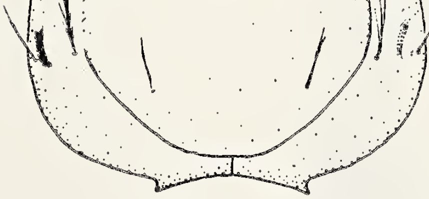

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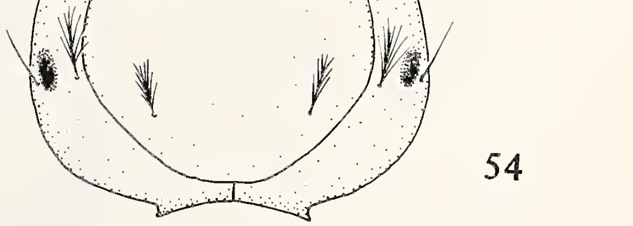
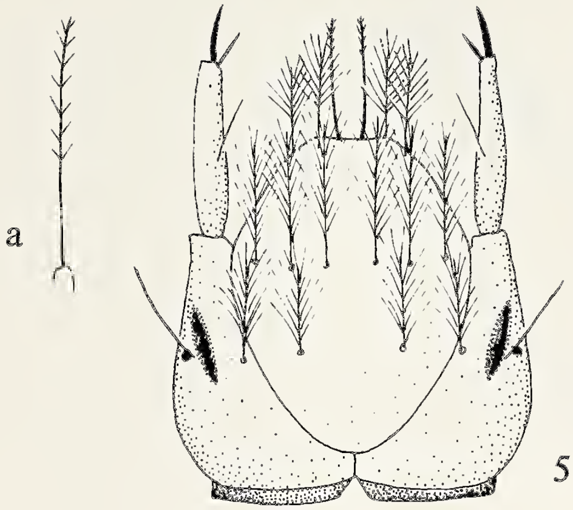


54

PLATE VII	*Anopheles* species, fourth instar larva, head
Figure 55	*Anopheles walkeri*; a. inner clypeal hair
56	*An. barberi*
57	*An. punctipennis*
58	*An. earlei*; a. inner clypeal hair
59	*An. crucians*



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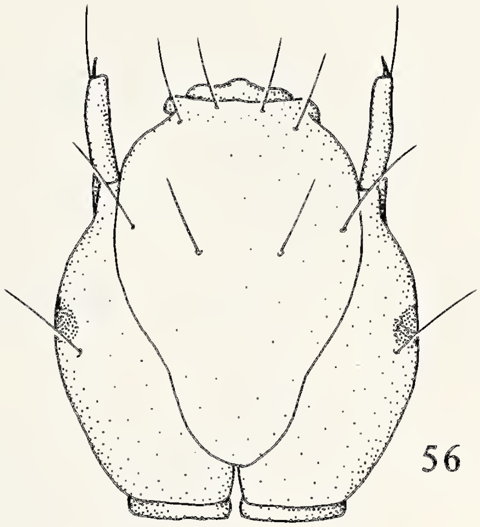

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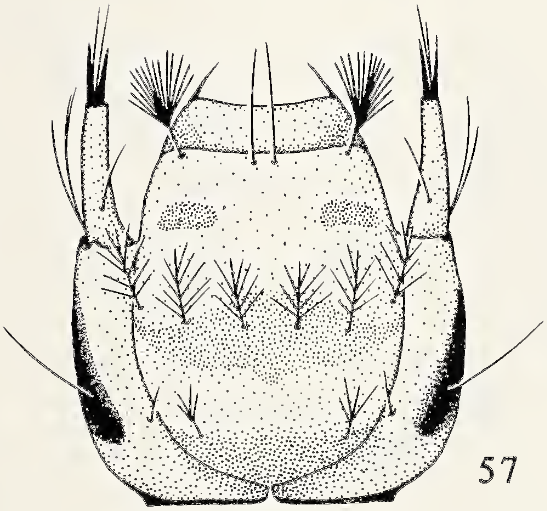

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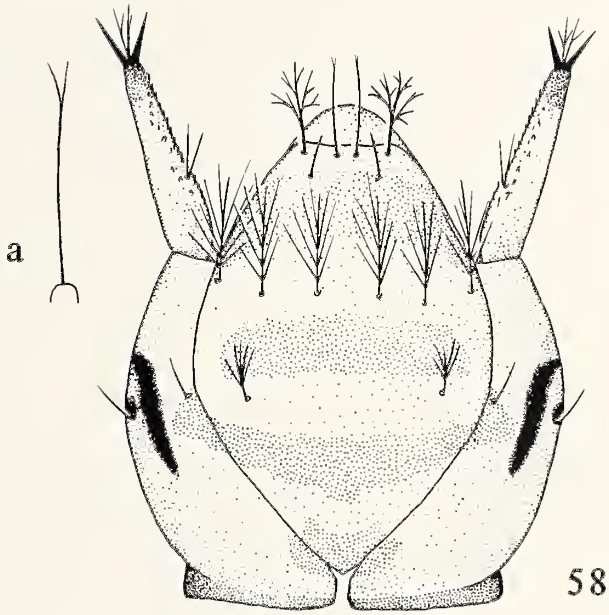

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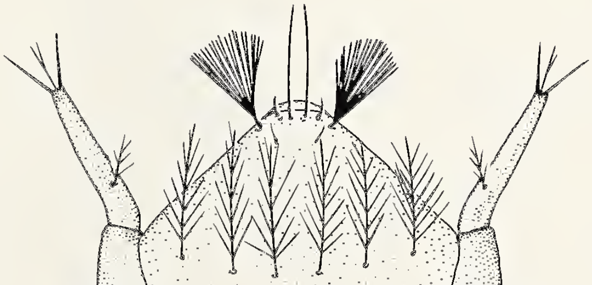
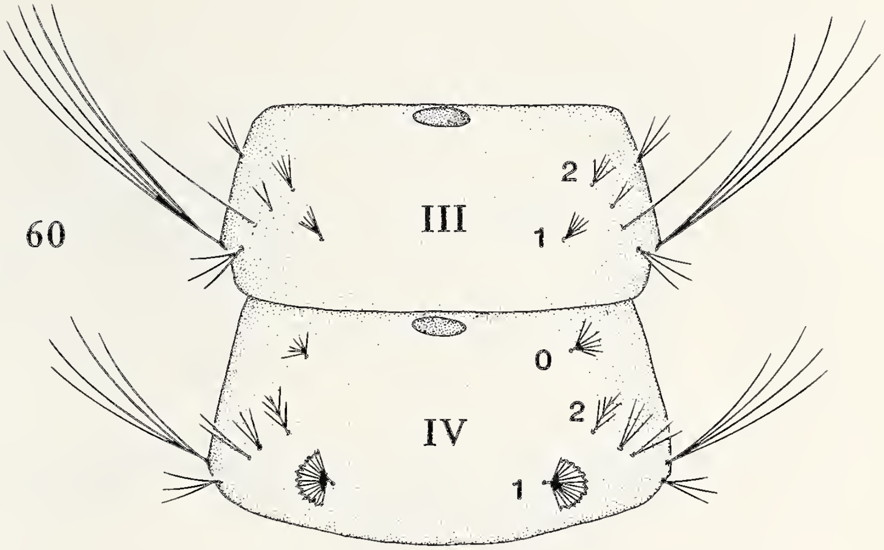


59

PLATE VIII	*Anopheles* species, fourth instar larva, abdominal segments
Figure 60	***Anopheles crucians***
61	***An. earlei***
62	***An. punctipennis***



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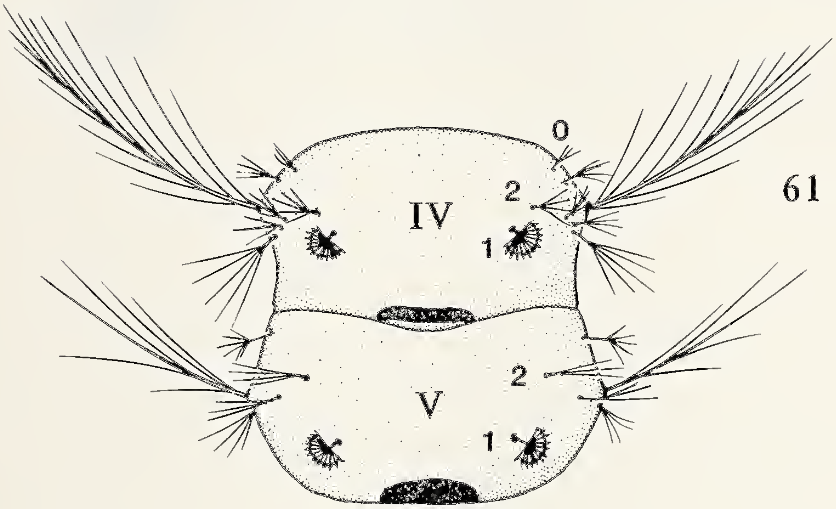

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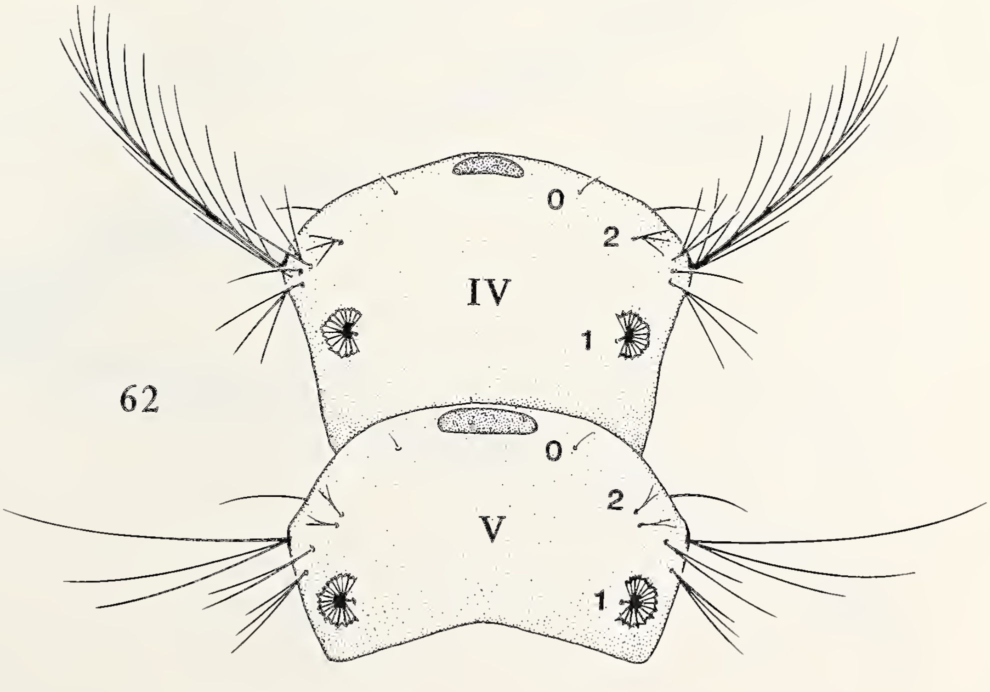
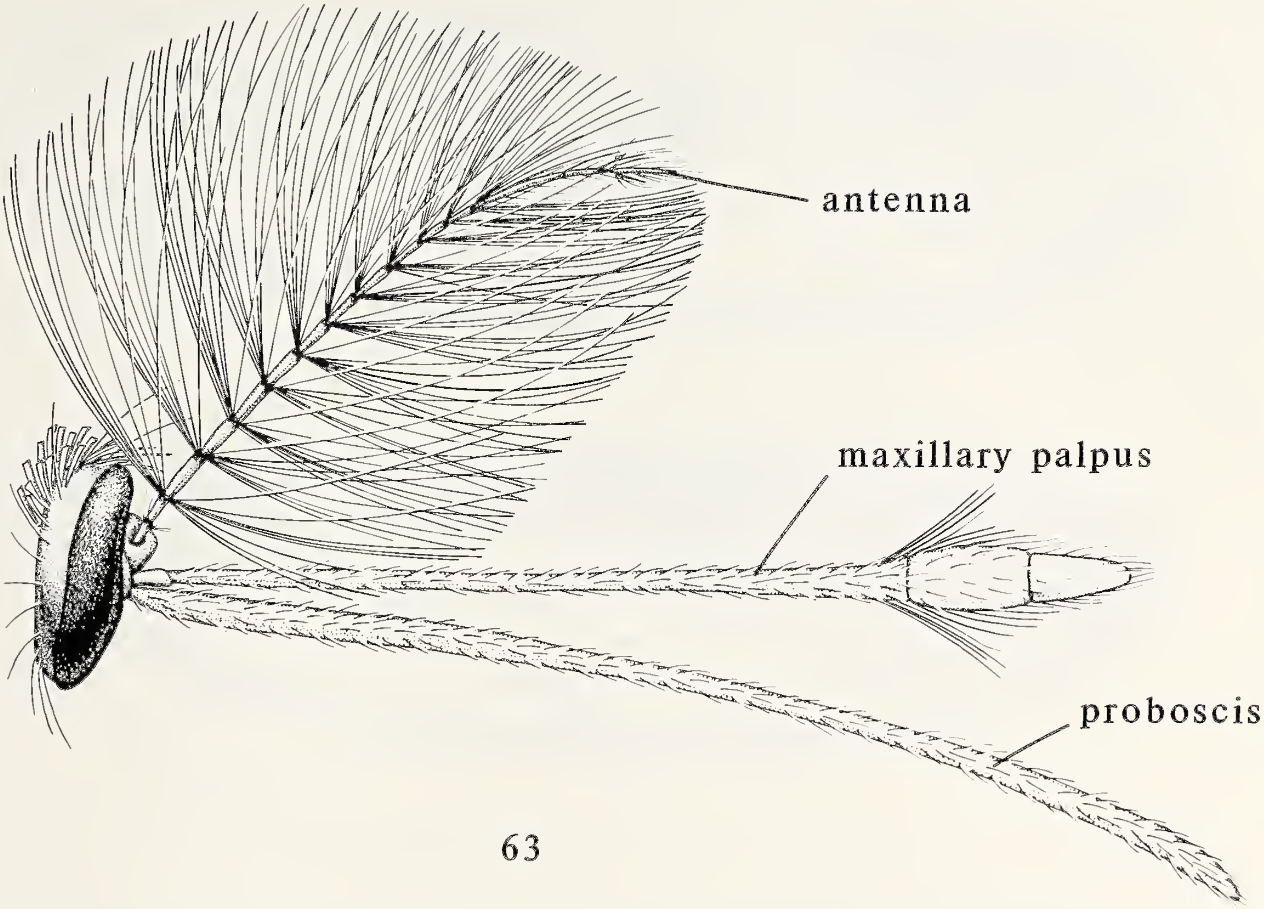


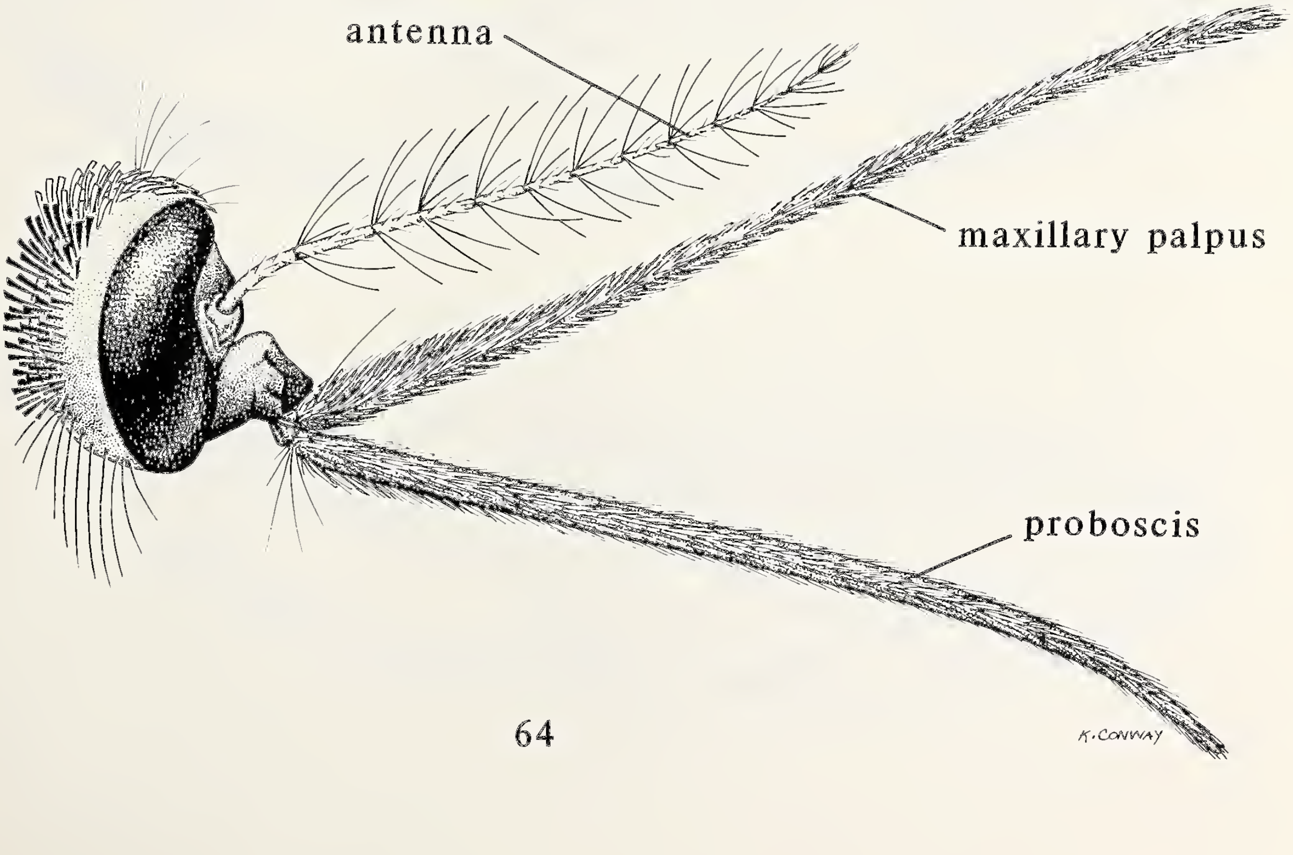
62

PLATE IX Head of adult anopheline mosquito, *Anopheles punctipennis*

Figure 63 Male
64 Female

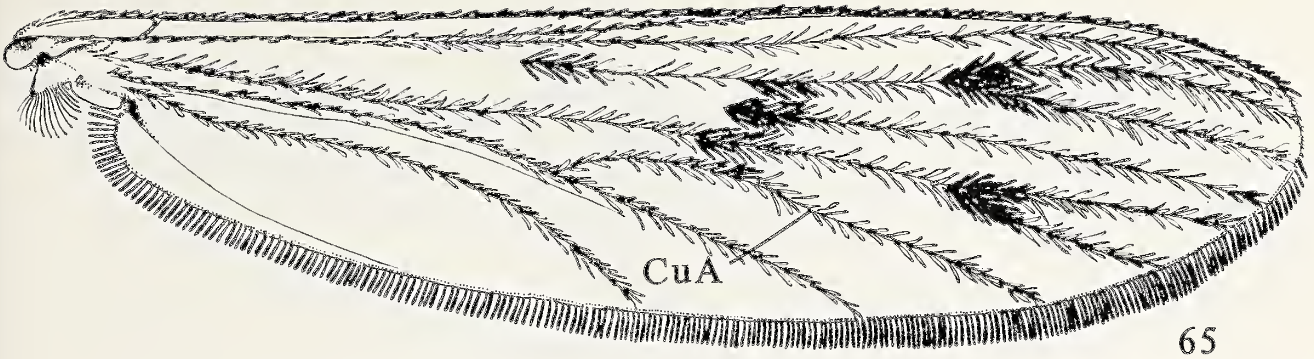

antenna
maxillary palpus
proboscis

63


antenna
maxillary palpus
proboscis
K. CONWAY

64

PLATE X	*Anopheles* species, wing
Figure 65	*Anopheles crucians*
66	*An. bradleyi*; CuA — Cubitus anterior vein
67	*An. perplexens*
68	*An. punctipennis*



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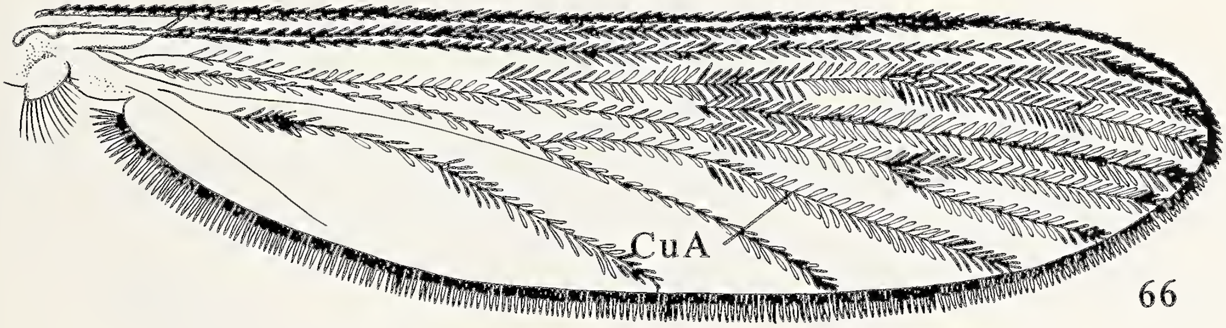

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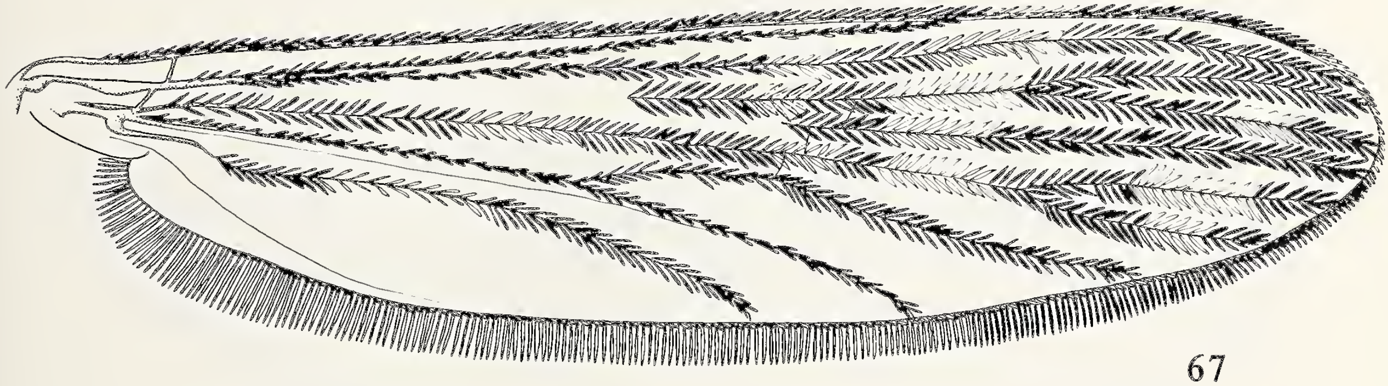

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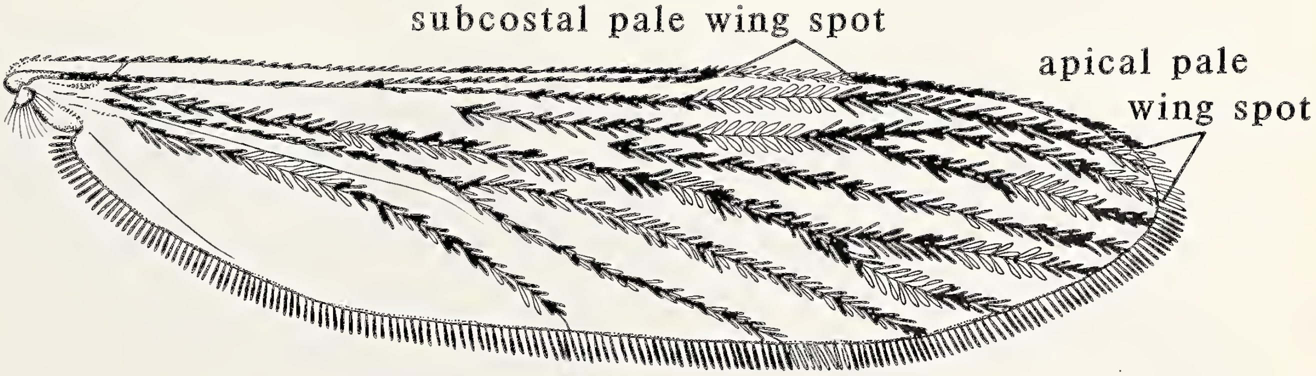
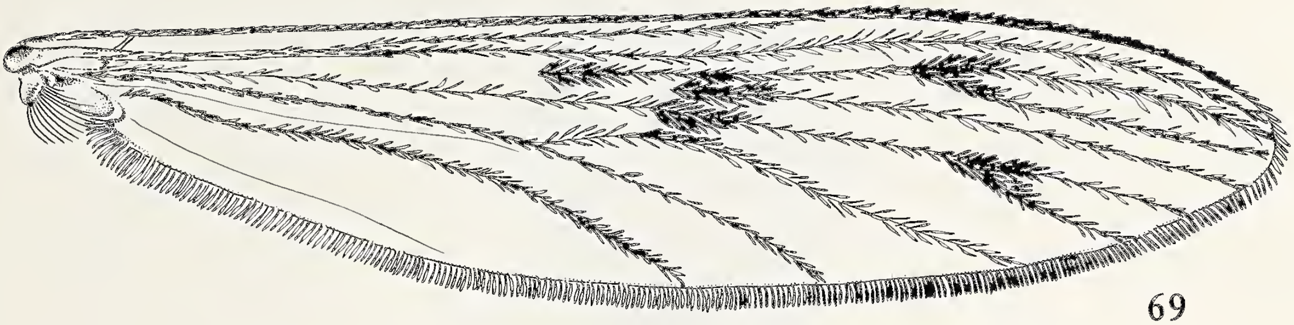


68

PLATE XI *Anopheles* species, wing

Figure 69	*Anopheles earlei*
70	*An. barberi*
71	*An. quadrimaculatus*
72	*An. walkeri*



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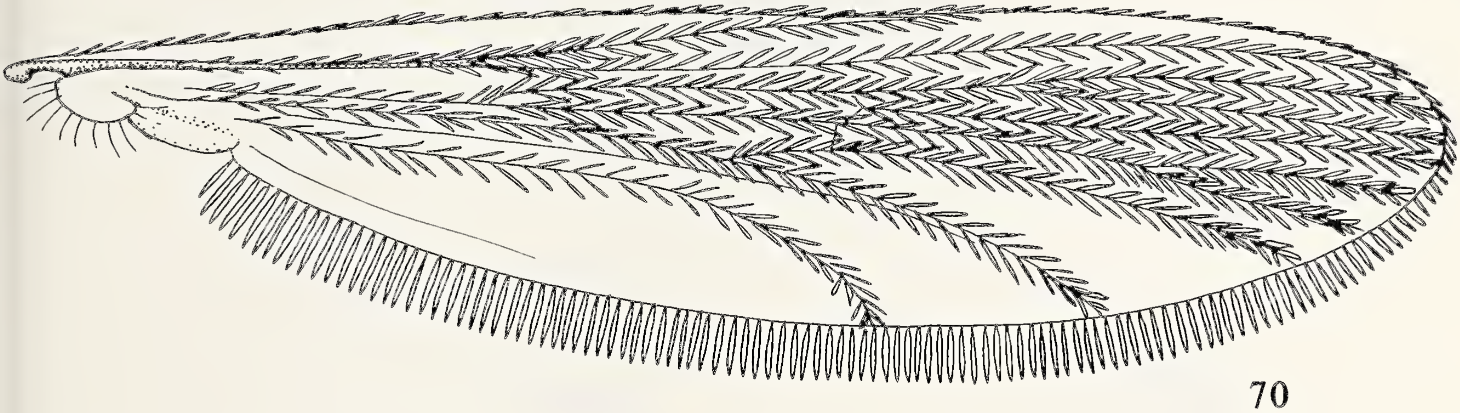

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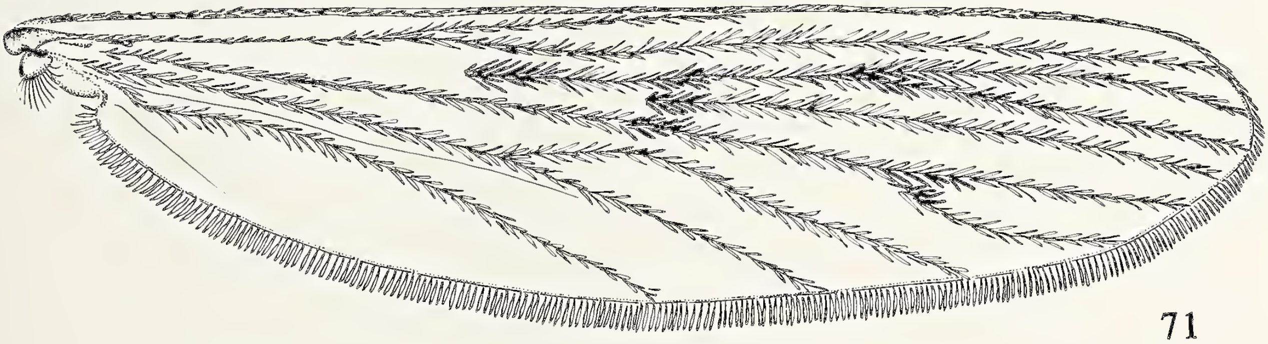

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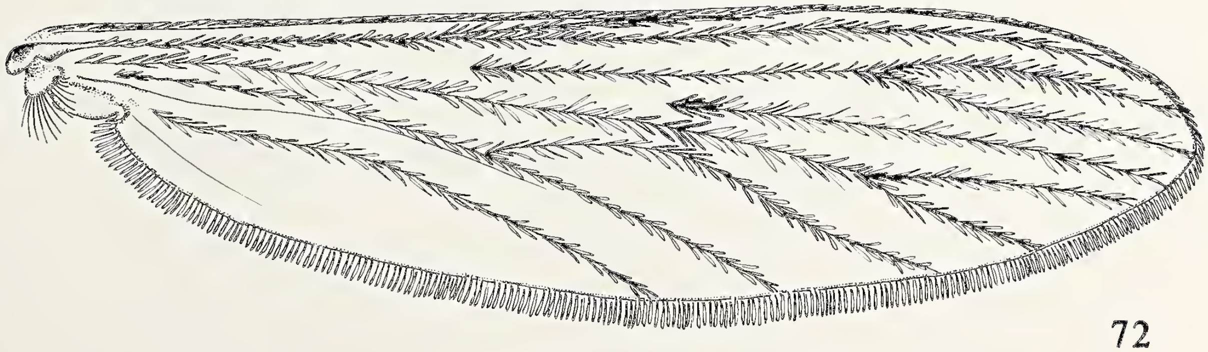
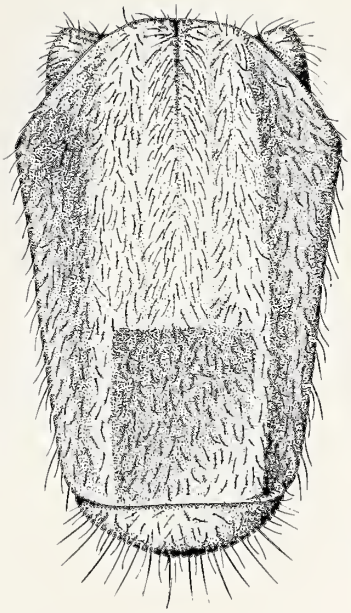


72

PLATE XII	*Anopheles* species
Figure 73	*Anopheles earlei*, mesonotum and scutellum
74	Halter. a. *An. walkeri*; b. *An. earlei*
75	Maxillary palpus. a. *An. walkeri*; b. *An. earlei*



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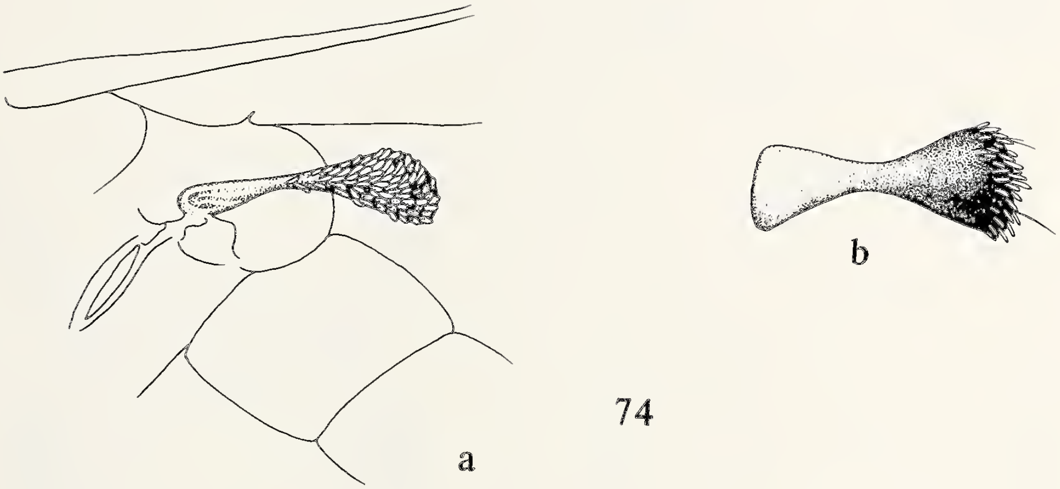
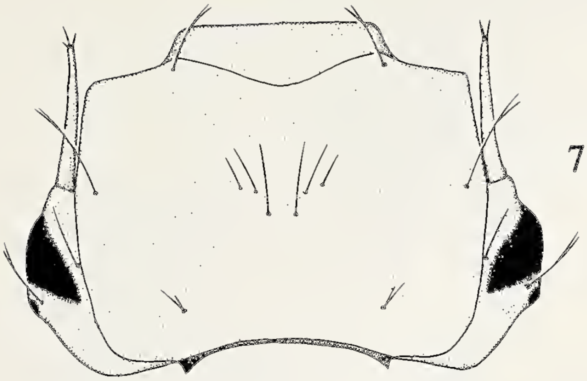


74

75

PLATE XIII *Psorophora* species, fourth instar larva, head

Figure 76	***Psorophora ciliata***
77	***Ps. mathesoni***
78	***Ps. columbiae***
79	***Ps. ferox***



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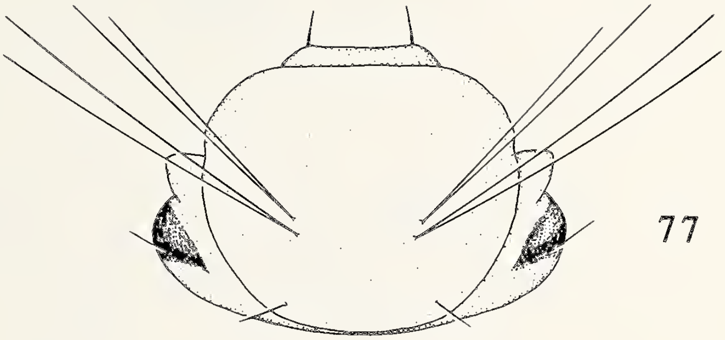

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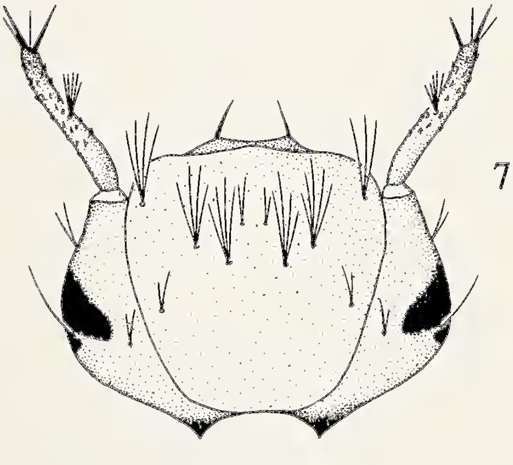

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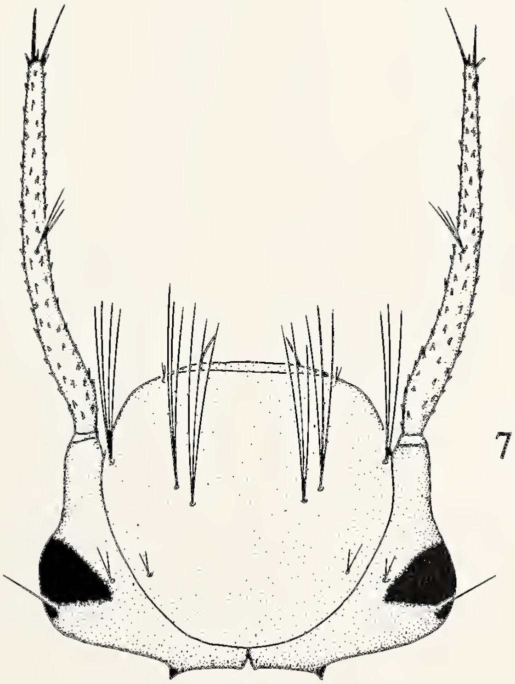
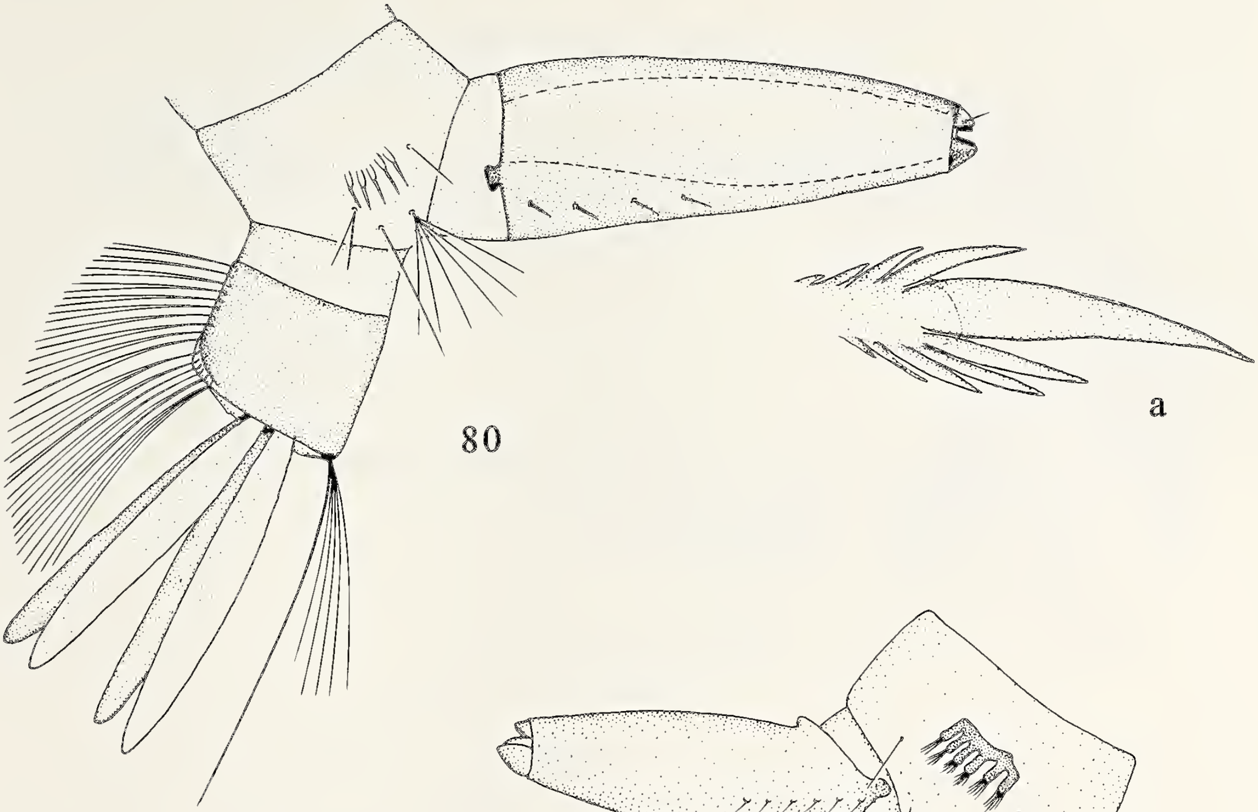


79

PLATE XIV	*Psorophora* species, fourth instar larva, terminal segments
Figure 80	*Psorophora columbiae*; a. comb scale
81	*Ps. discolor*
82	*Ps. horrida*



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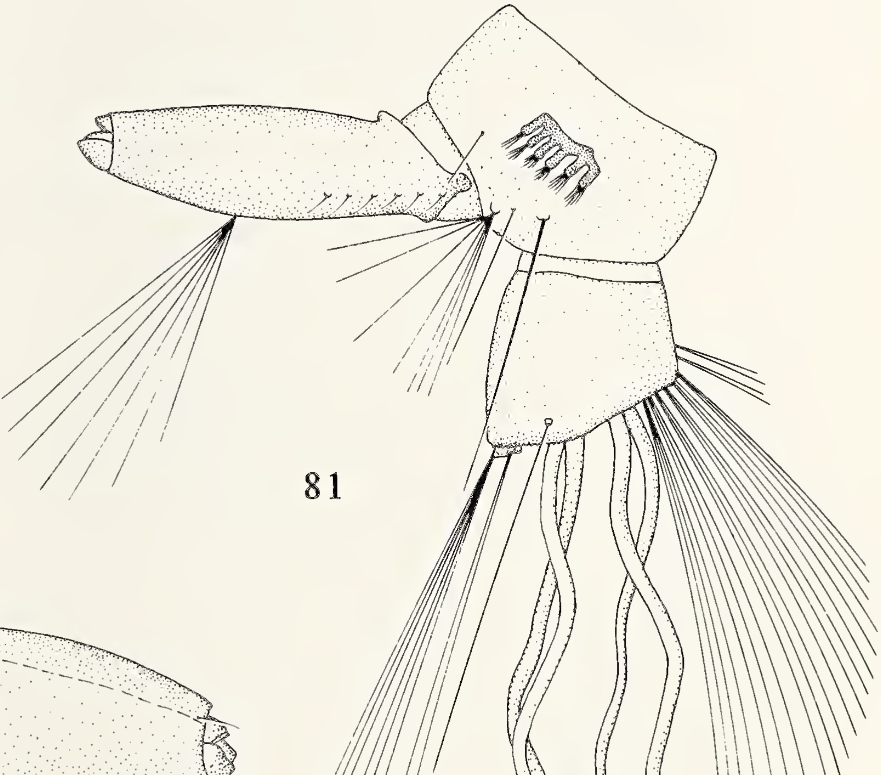

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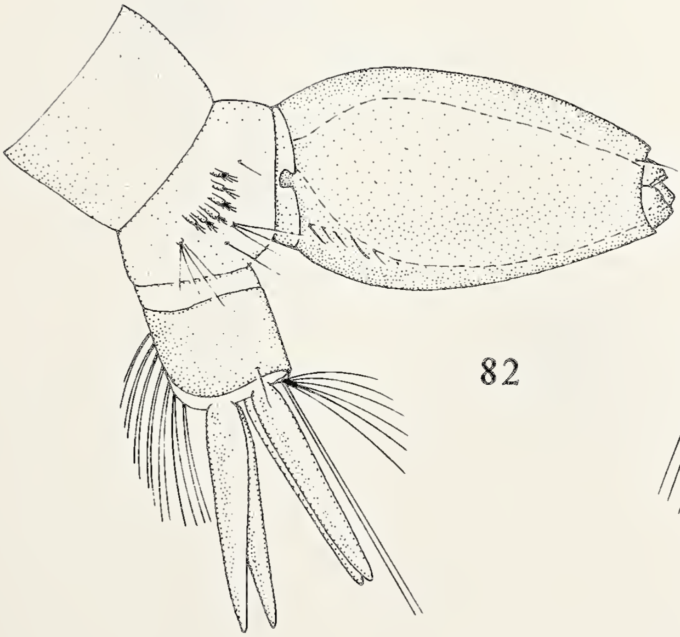
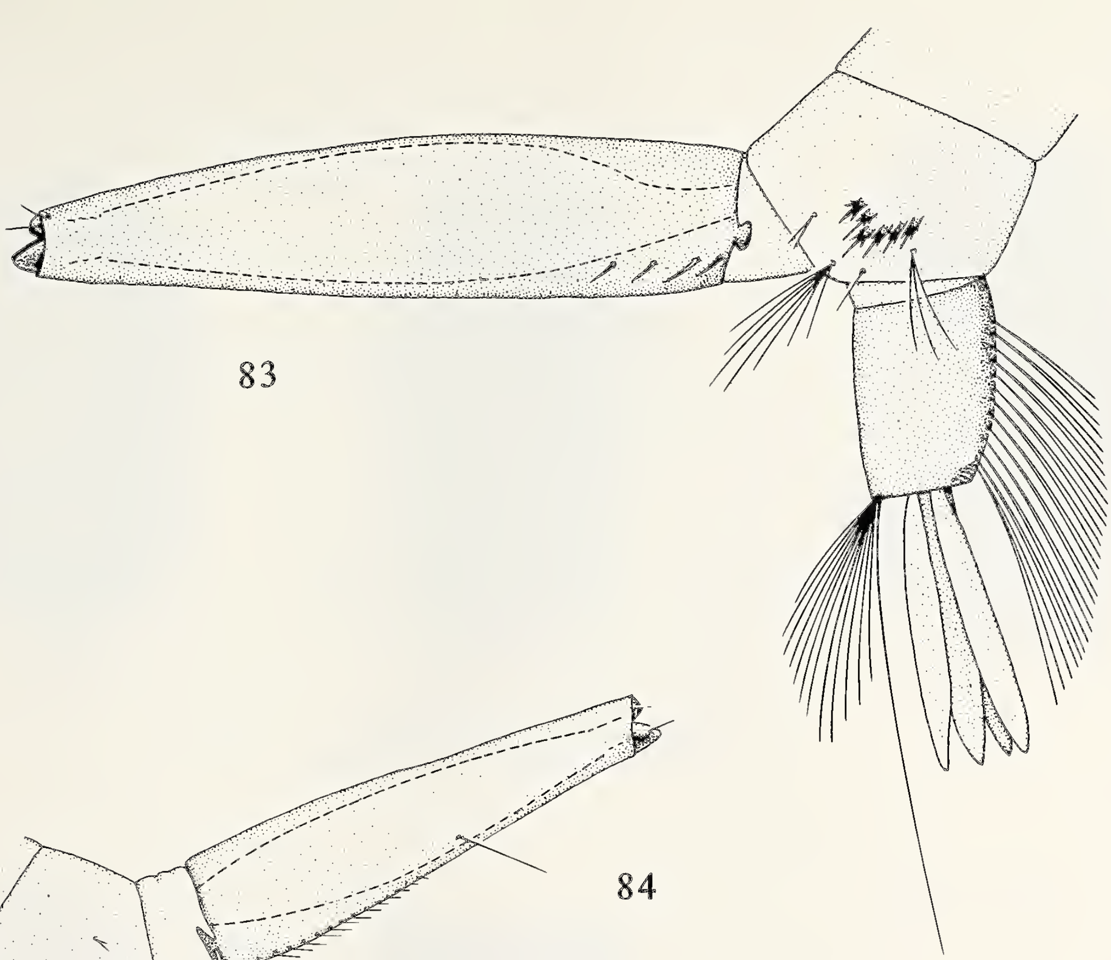


82

PLATE XV	*Psorophora* species, fourth instar larva, terminal segments
Figure 83	*Psorophora ferox*
84	*Ps. ciliata*; a. comb scale
85	*Ps. mathesoni*



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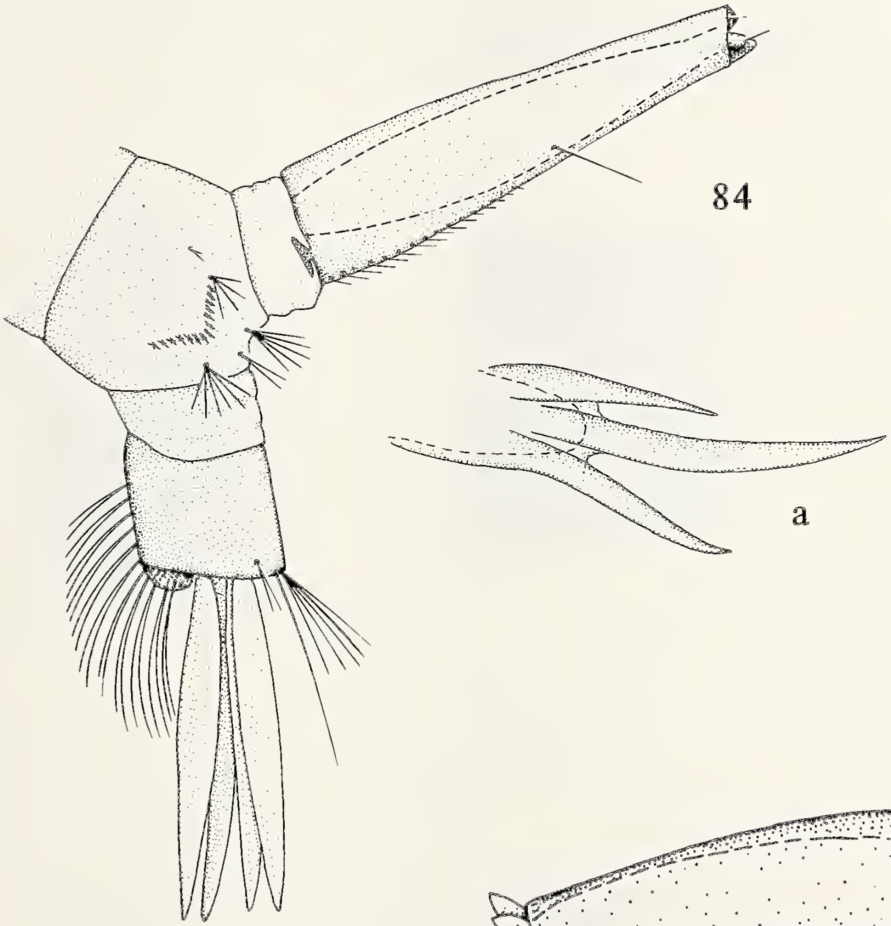

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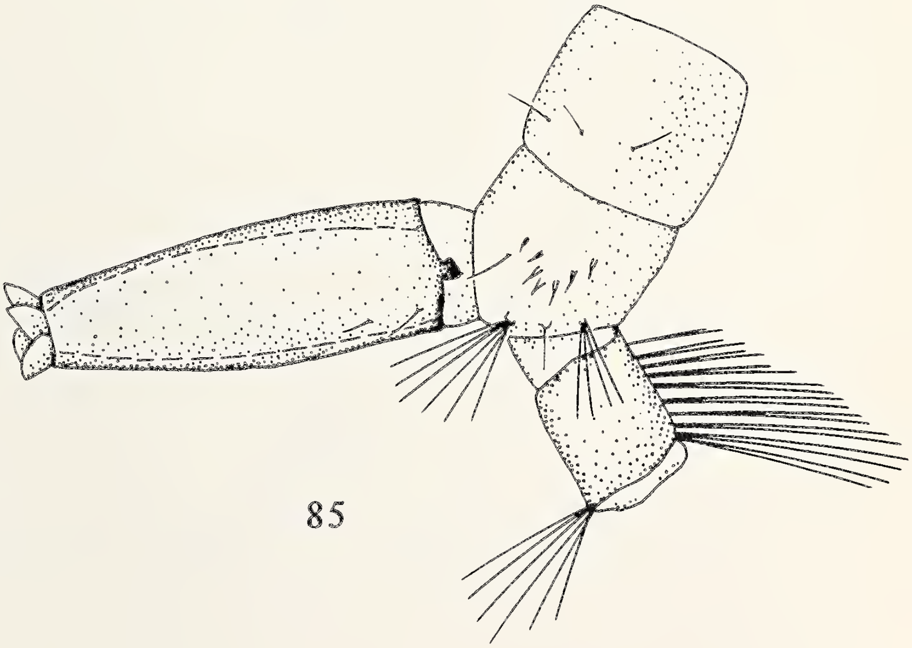
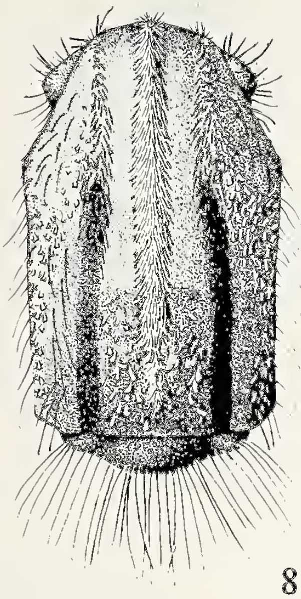


85

PLATE XVI	*Psorophora* species, adult female
Figure 86	*Psorophora ciliata*, mesonotum
87	*Ps. mathesoni*, mesonotum
88	*Ps. ferox*, mesonotum
89	*Ps. horrida*, mesonotum
90	*Ps. horrida*, abdominal terga
91	*Ps. horrida*, abdominal cerci
92	*Ps. ciliata*, thorax, lateral aspect



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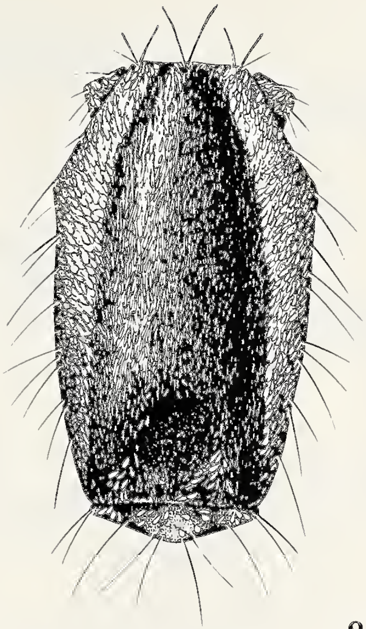

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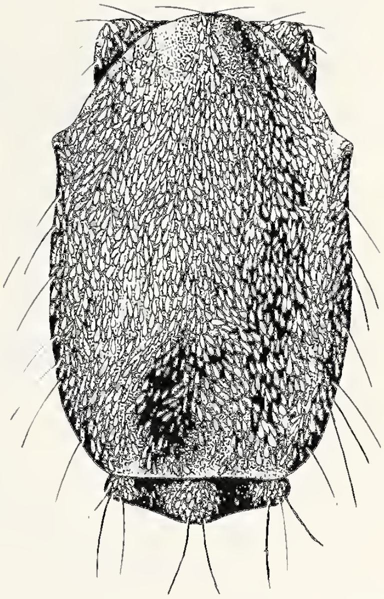

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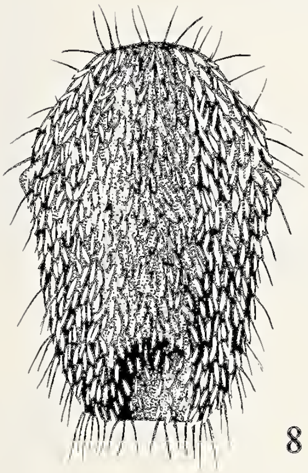

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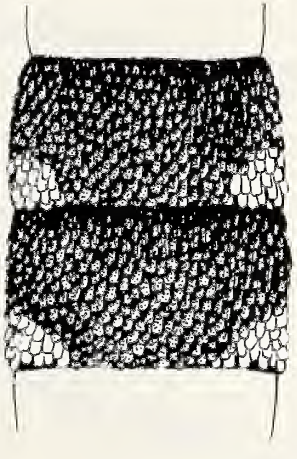

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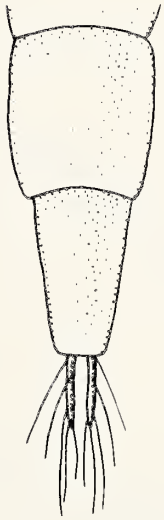

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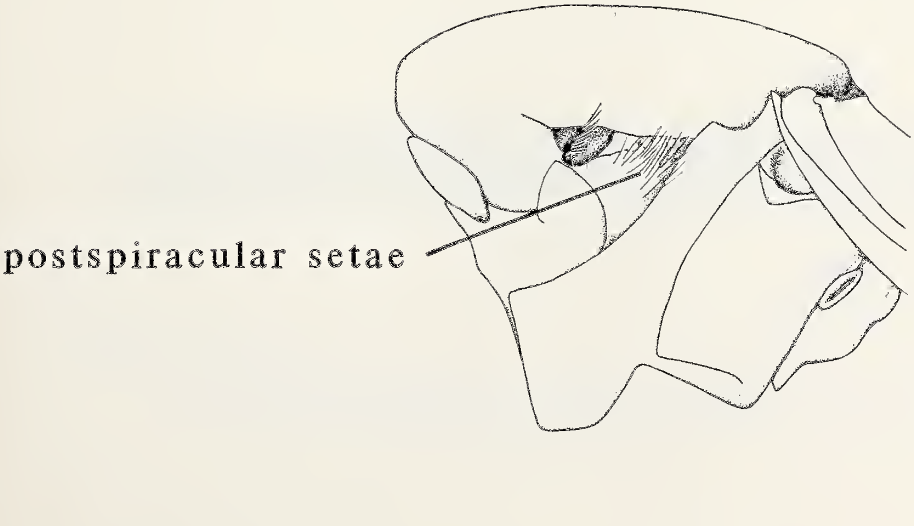

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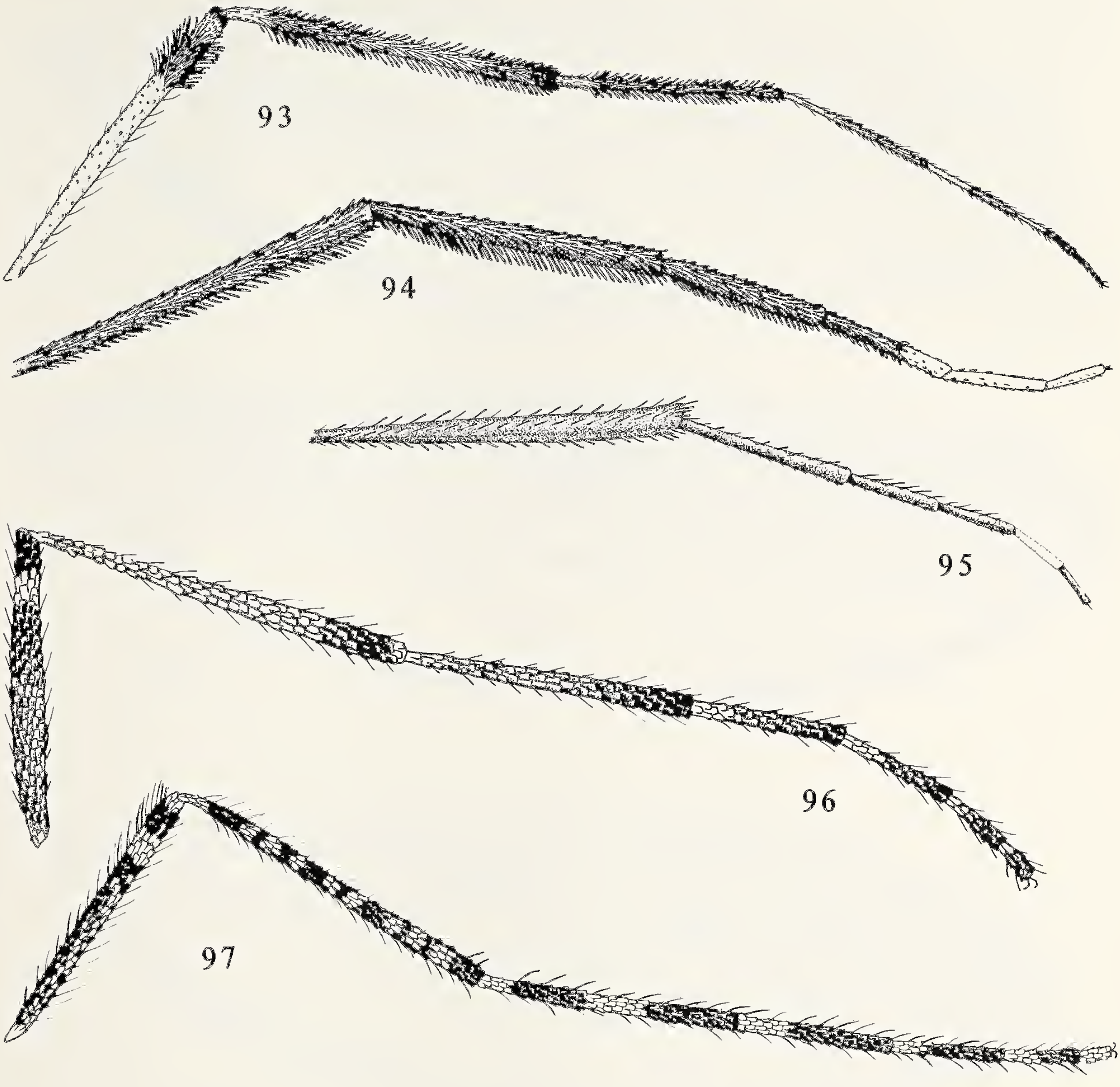
PLATE XVII	*Psorophora* species, adult female
Figure 93	*Psorophora ciliata*, hindleg
94	*Ps. ferox*, hindleg
95	*Ps. mathesoni*, hindleg
96	*Ps. discolor*, hindleg
97	*Ps. columbiae*, hindleg
98	*Ps. columbiae*, maxillary palpus
99	*Ps. ciliata*, maxillary palpus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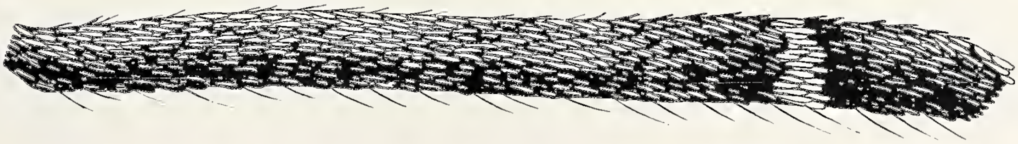
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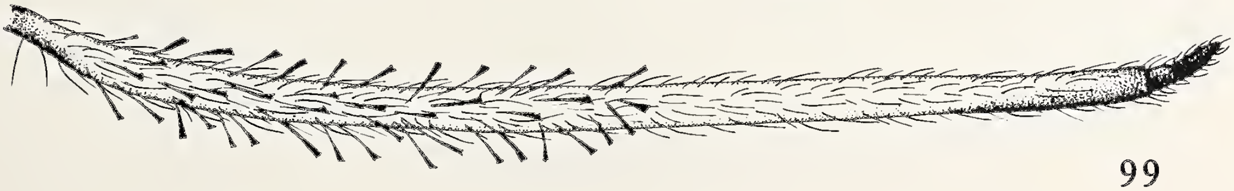
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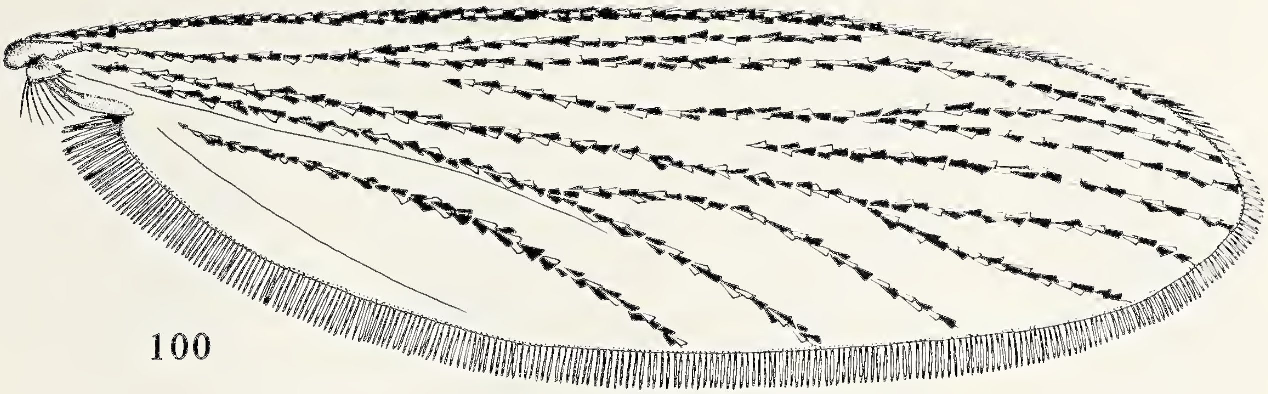
PLATE XVIII	*Psorophora* species, wing
Figure 100	***Psorophora columbiae***
101	***Ps. discolor***
102	***Ps. horrida***
103	***Ps. ciliata***



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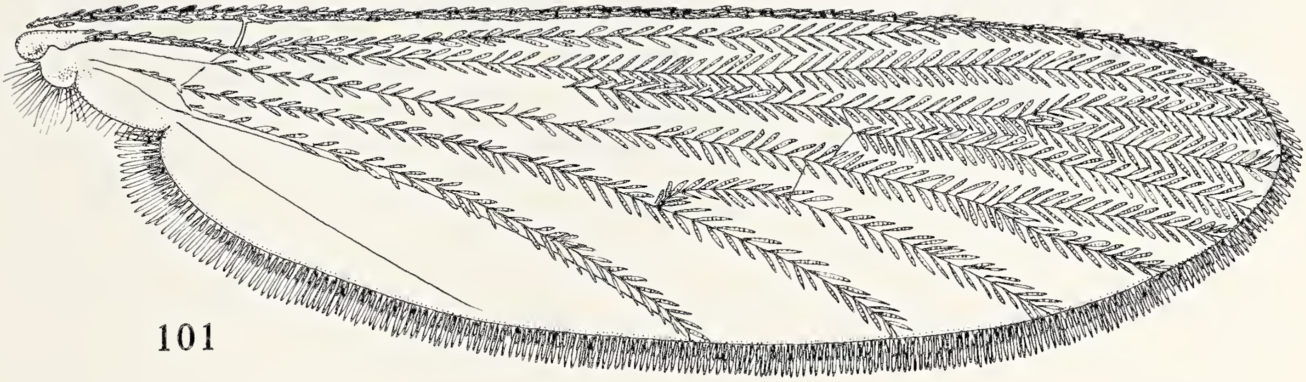

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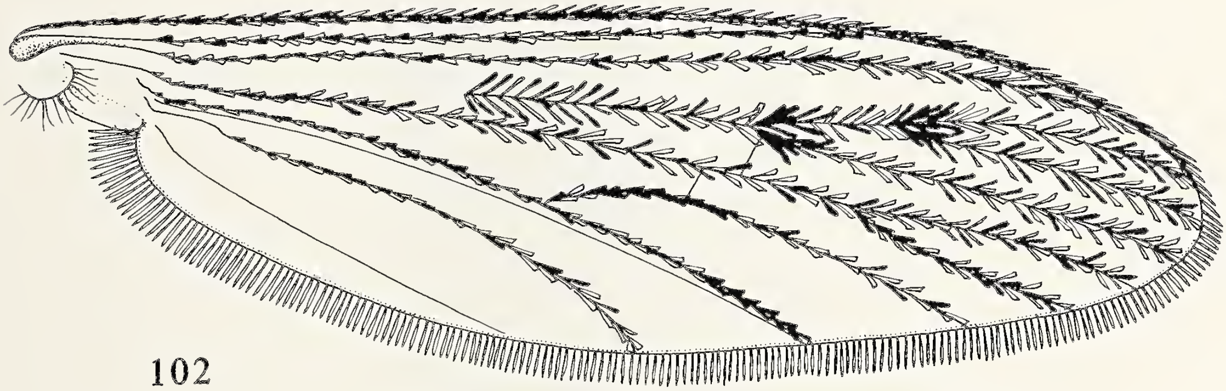

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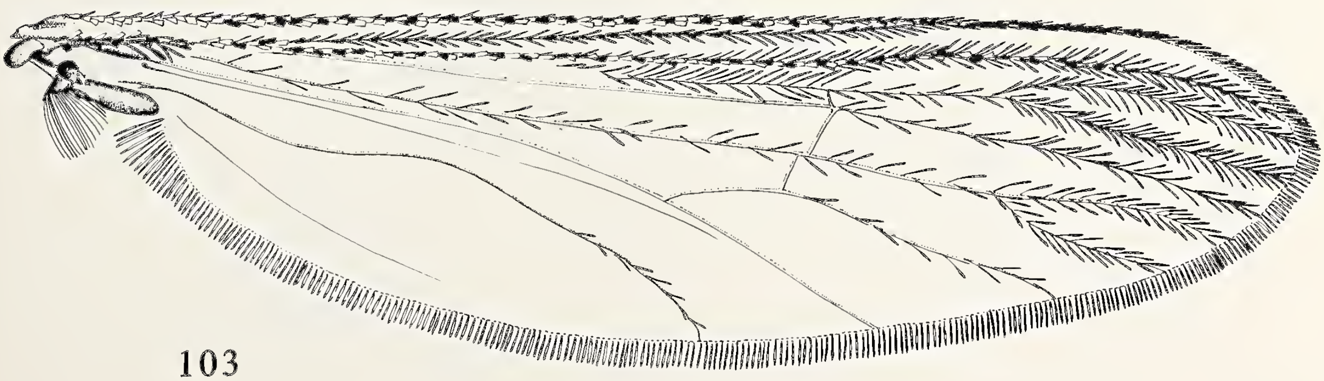

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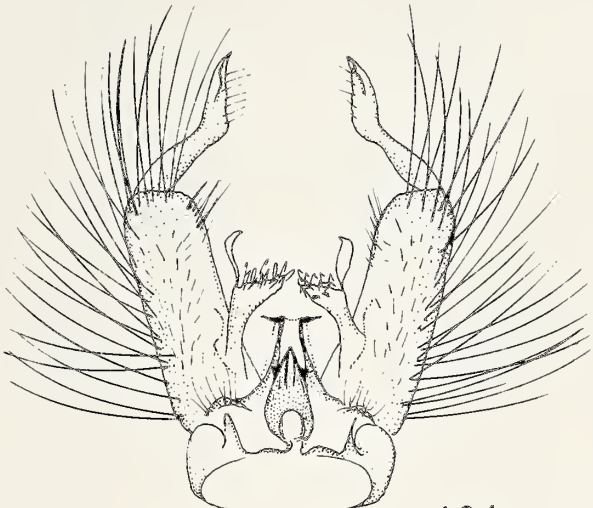
PLATE XIX	*Psorophora* species, male terminalia
Figure 104	*Psorophora ciliata*
105	*Ps. columbiae*
106	*Ps. mathesoni*
107	*Ps. horrida*, claspette
108	*Ps. discolor*, phallosome



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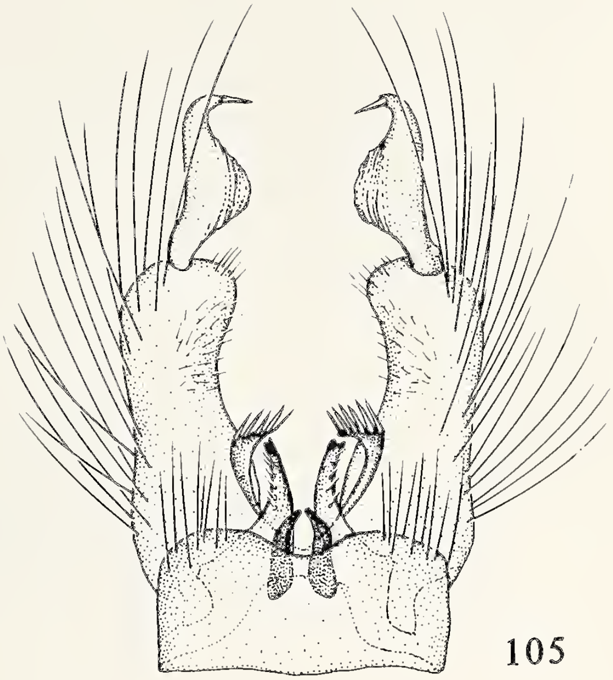

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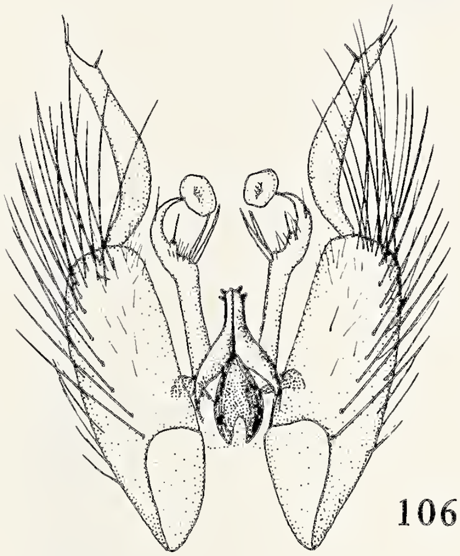

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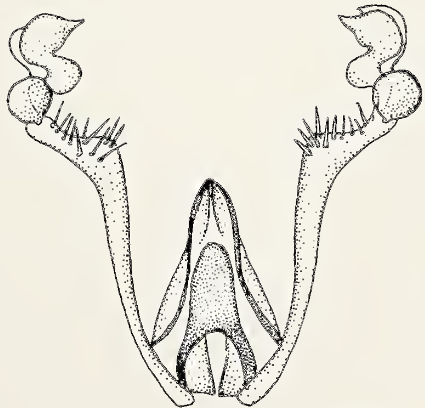

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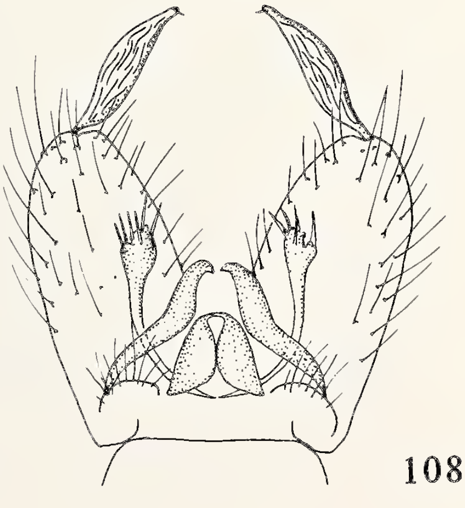

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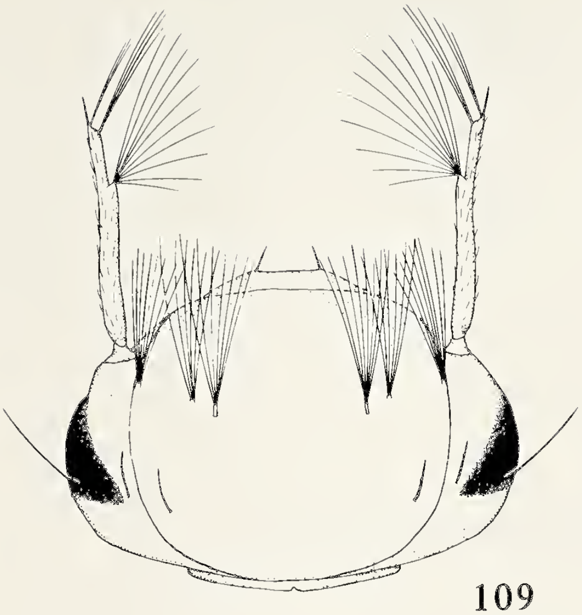
PLATE XX	*Culex* species, fourth instar larva, head
Figure 109	*Culex pipiens*
110	*Cx. salinarius*
111	*Cx. erraticus*
112	*Cx. territans*



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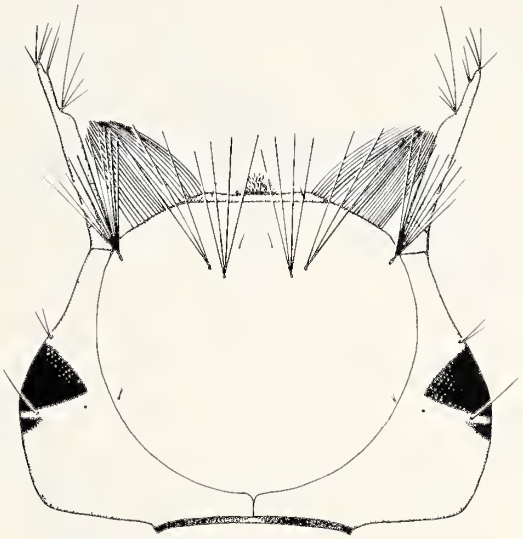

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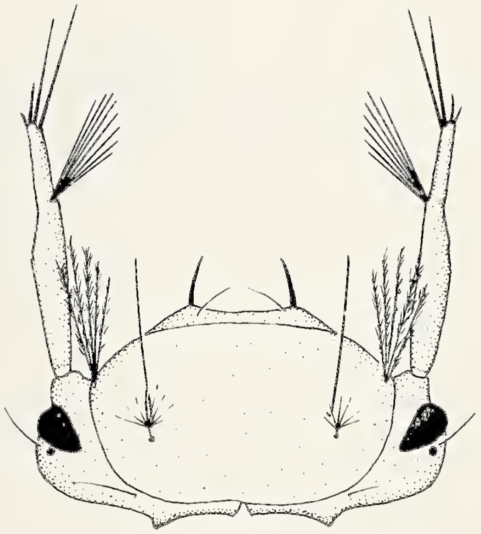

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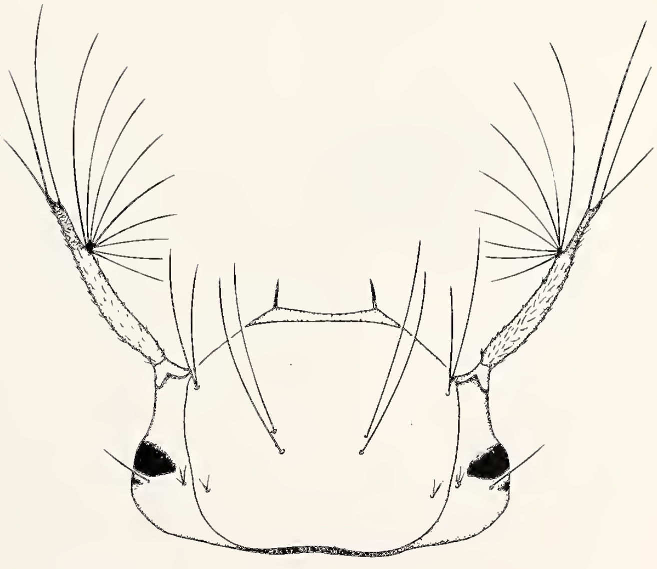

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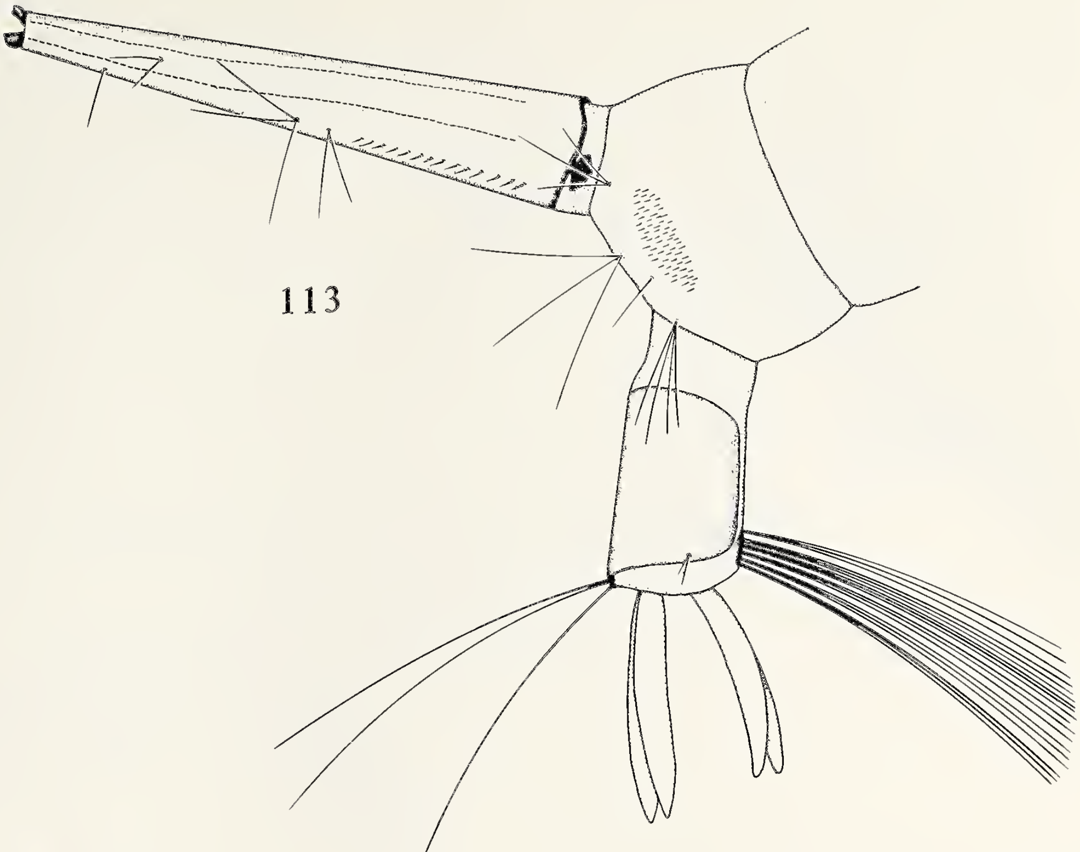
PLATE XXI *Culex pipiens*, larva

Figures 113-115 *Culex pipiens*, fourth instar larva, terminal segments



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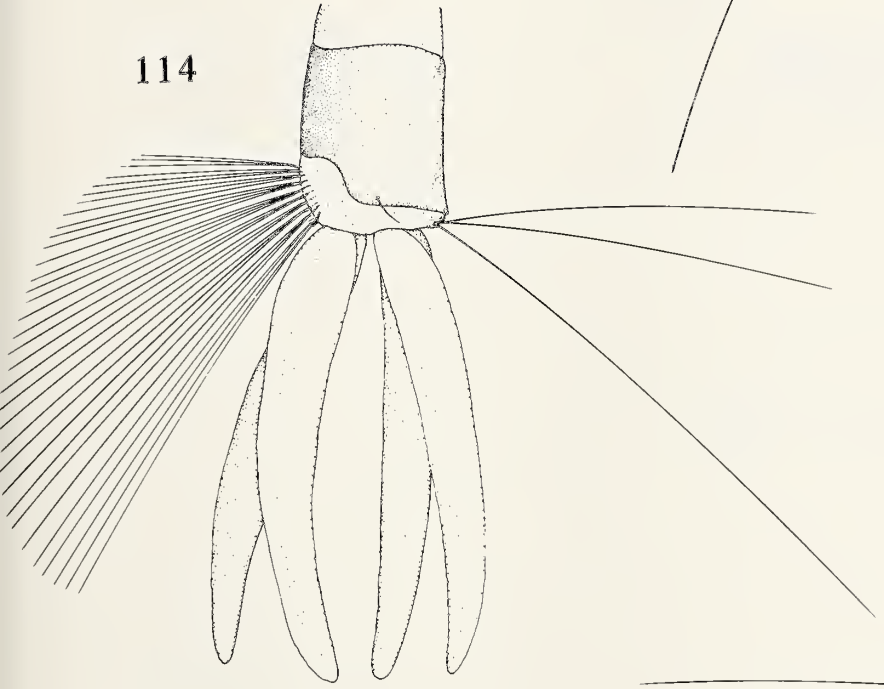

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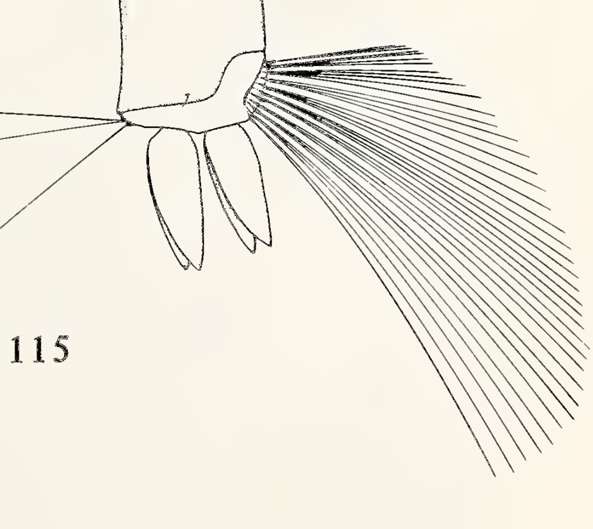

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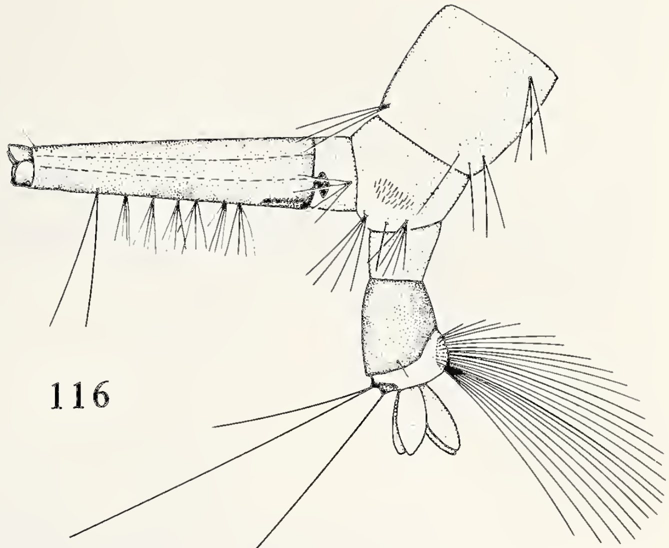
PLATE XXII	*Culex* species, fourth instar larva, terminal segments
Figure 116	*Culex tarsalis*
117	*Cx. territans*; a. individual comb scale
118	*Cx. salinarius*
119	*Cx. erraticus*; a. comb scales; b. individual comb scale



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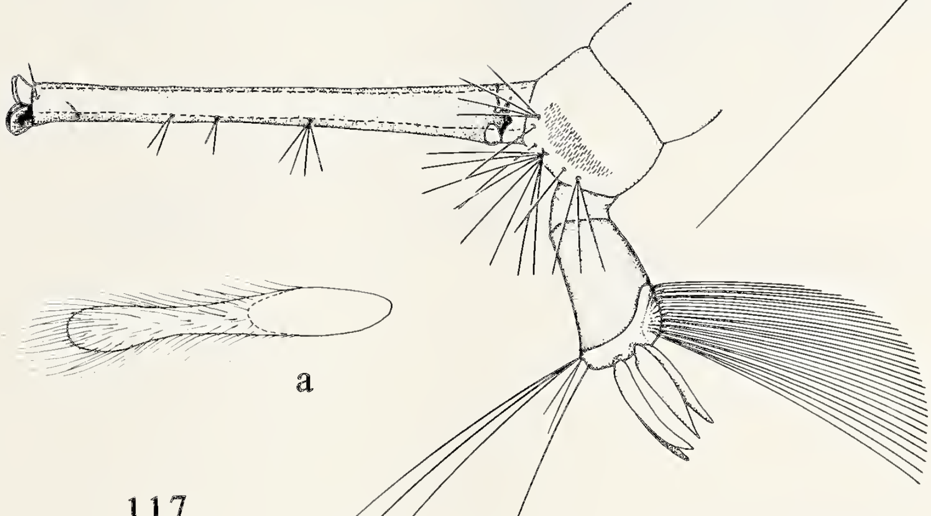

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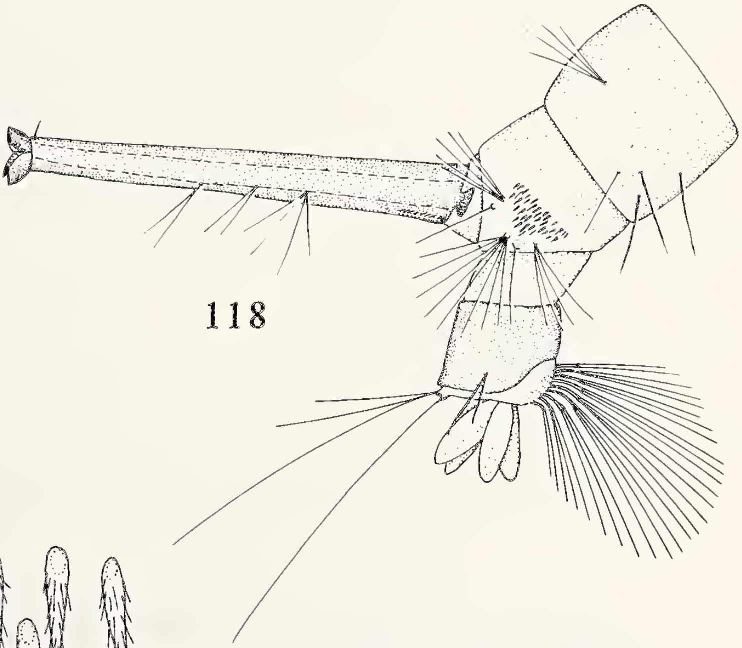

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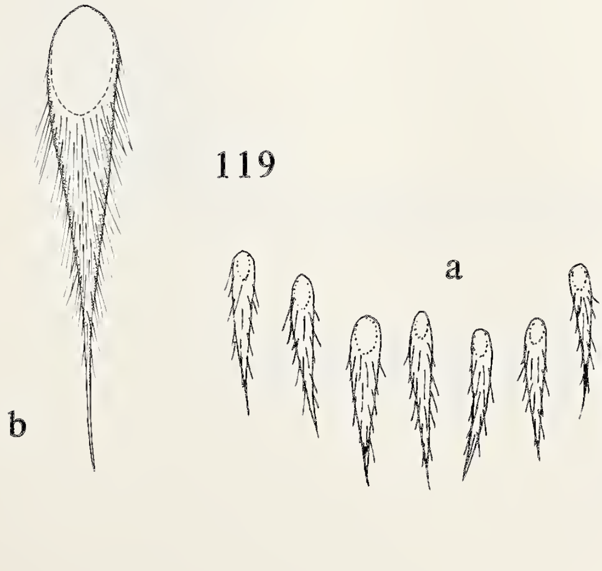

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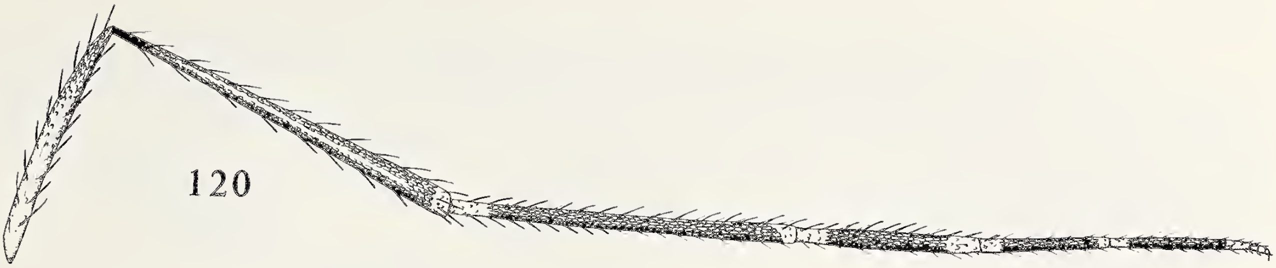
PLATE XXIII	*Culex* species, adult female
Figure 120	*Culex tarsalis*, hindleg
121	*Cx. pipiens*, hindleg
122	*Cx. restuans*, hindleg
123	*Cx. pipiens*, head
124	*Cx. tarsalis*, proboscis



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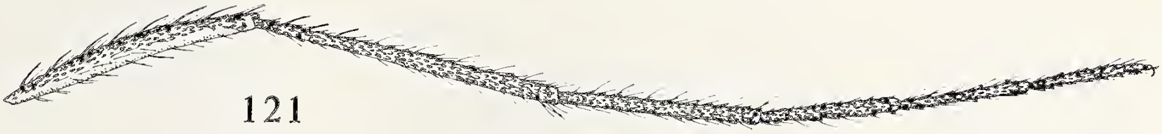

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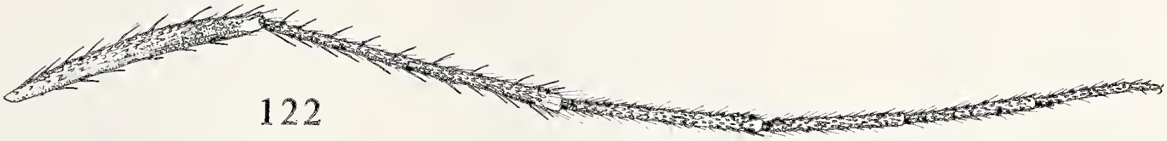

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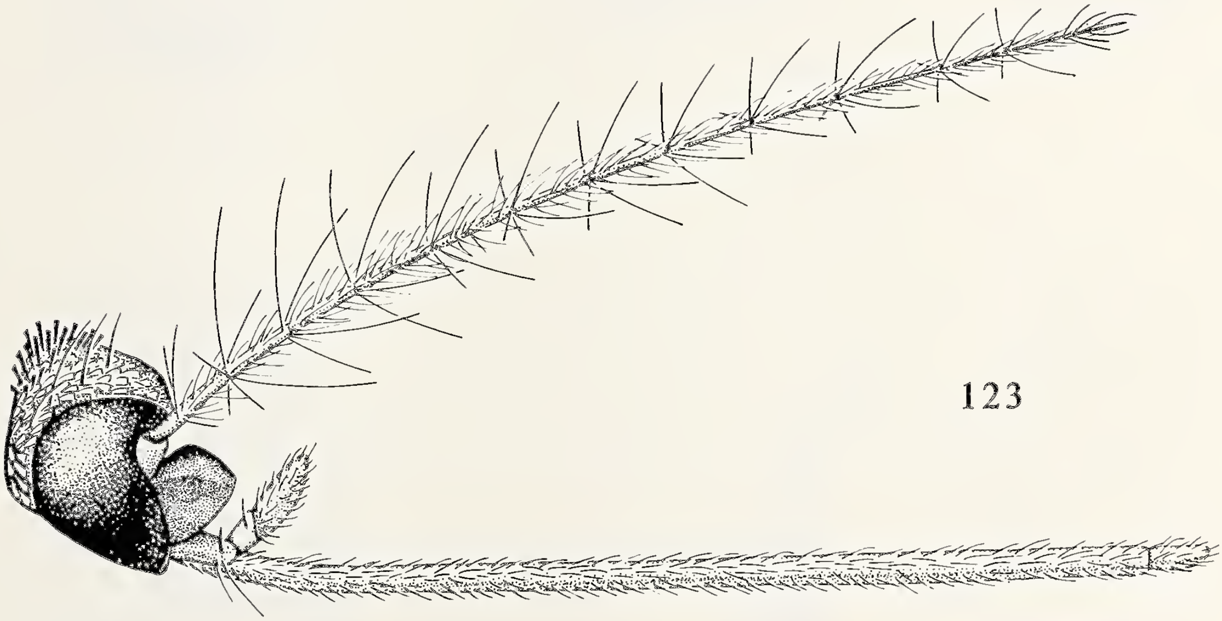

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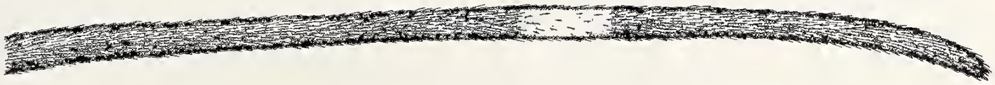
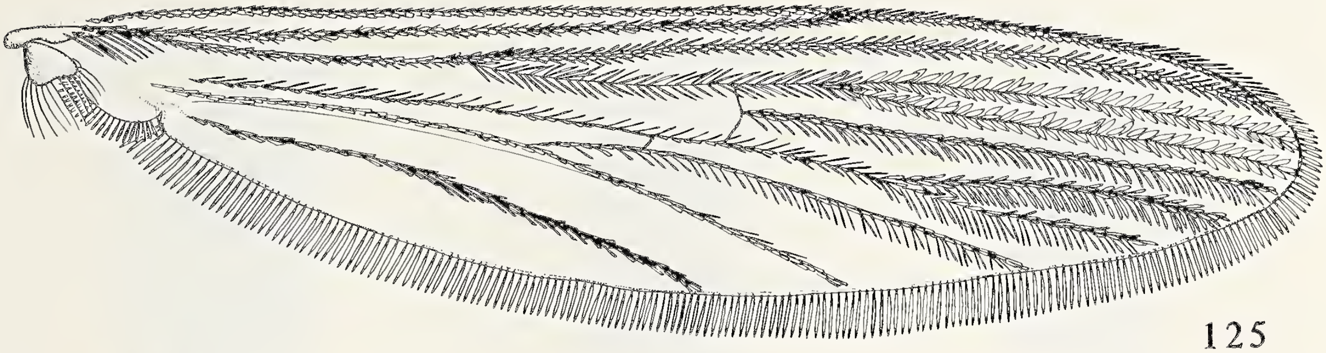


124

PLATE XXIV	*Culex* species, adult female
Figure 125	*Culex erraticus*, wing
126	*Cx. tarsalis*, mesonotum
127	*Cx. pipiens*, mesonotum
128	*Cx. restuans*, mesonotum
129	*Cx. territans*, mesonotum
130	*Cx. erraticus*, eye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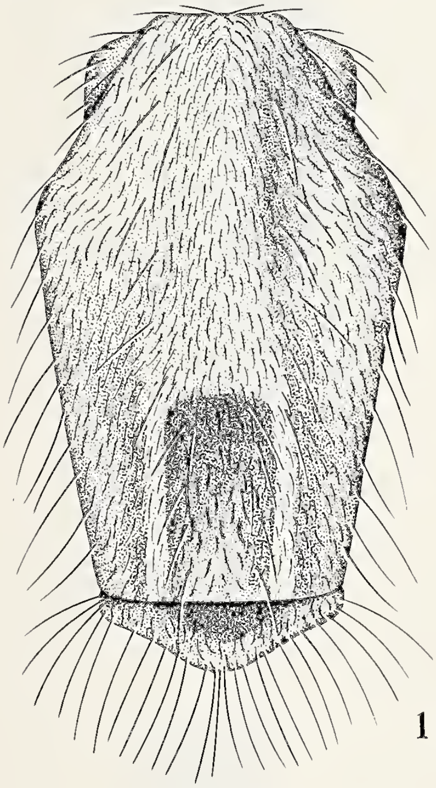
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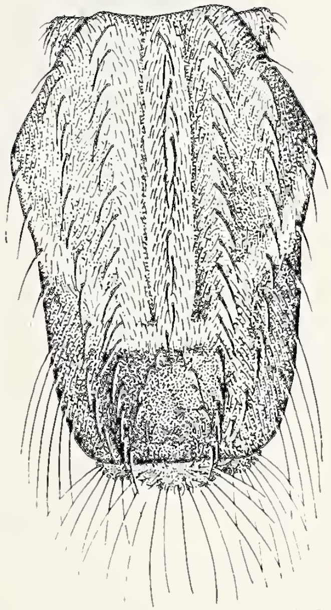
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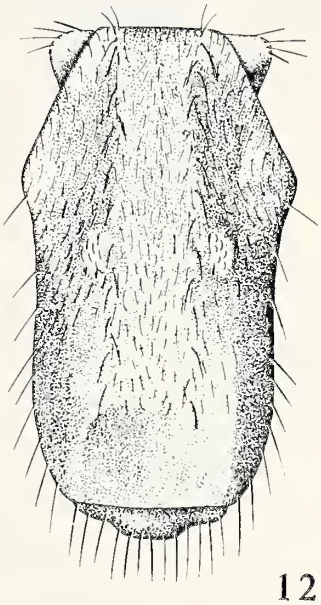
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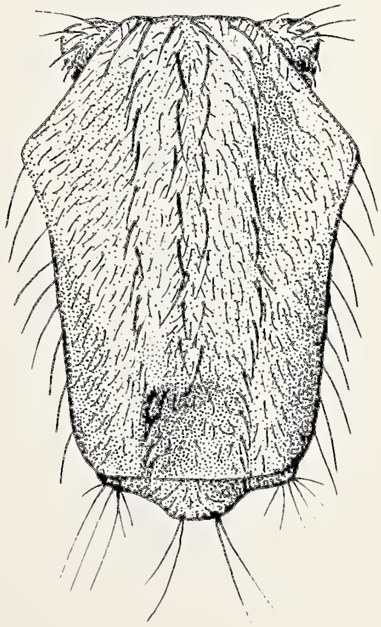
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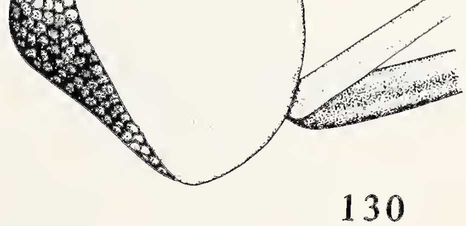
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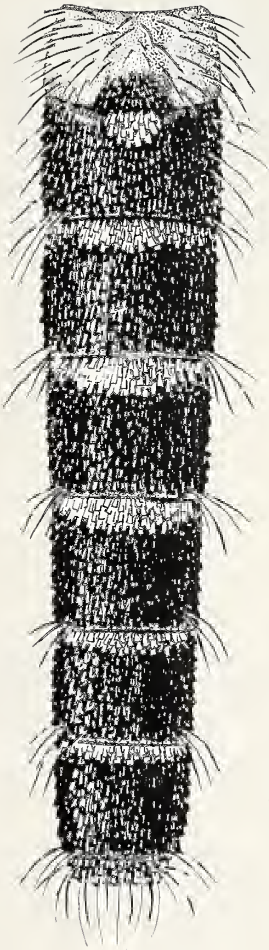
PLATE XXV	*Culex* species, adult female, abdomen
Figure 131	*Culex pipiens*, dorsal aspect
132	*Cx. restuans*, dorsal aspect
133	*Cx. salinarius*, dorsal aspect
134	*Cx. territans*, dorsal aspect
135	*Cx. erraticus*, ventral aspect
136	*Cx. salinarius*, ventral aspect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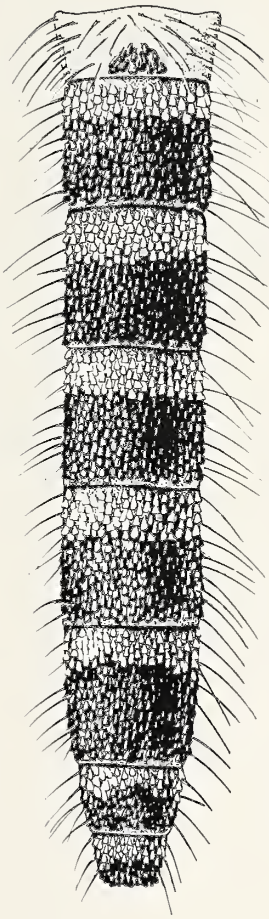
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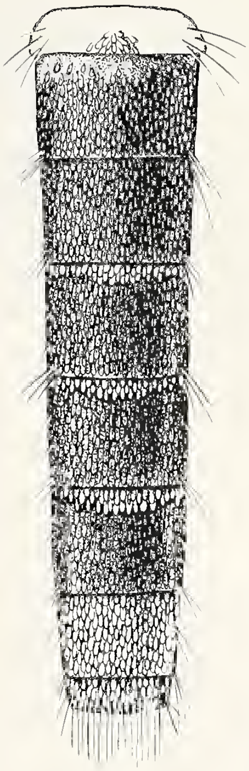
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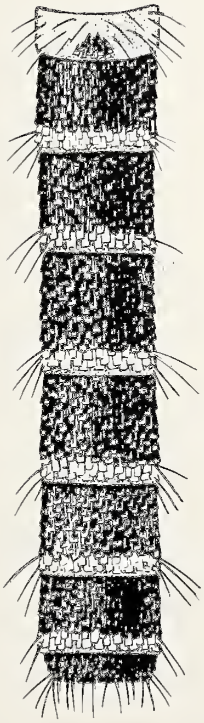
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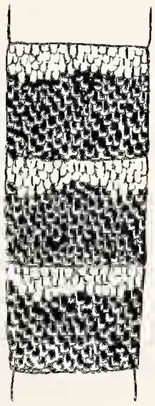
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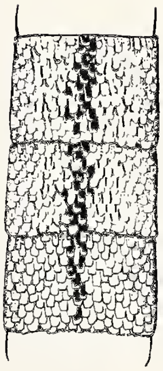
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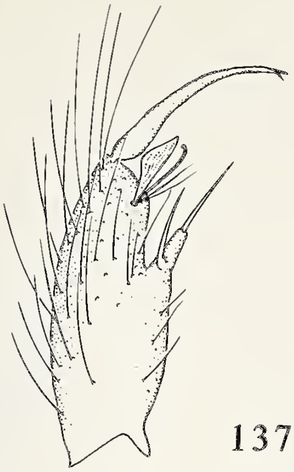
PLATE XXVI	*Culex* species, male terminalia
Figure 137	*Culex erraticus*, basistyle
138	*Cx. salinarius*
139	*Cx. tarsalis*
140	*Cx. restuans*
141	*Cx. territans*
142	*Cx. pipiens*
143	*Cx. quinquefasciatus*



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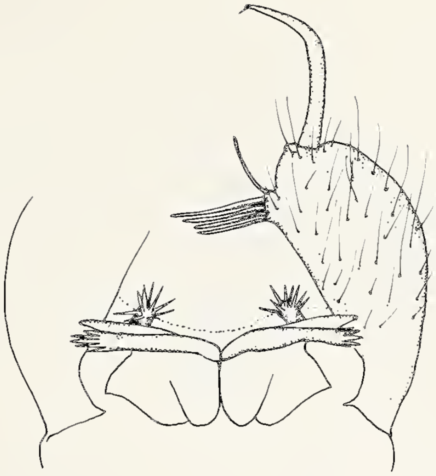

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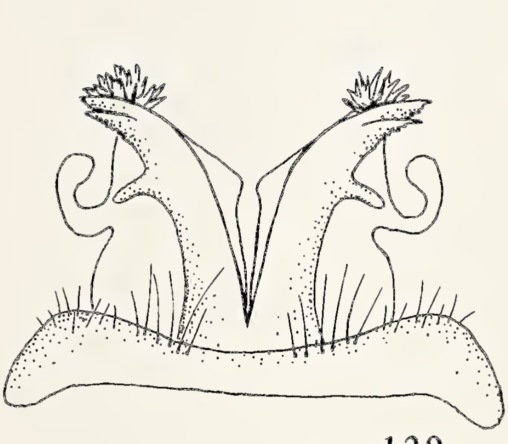

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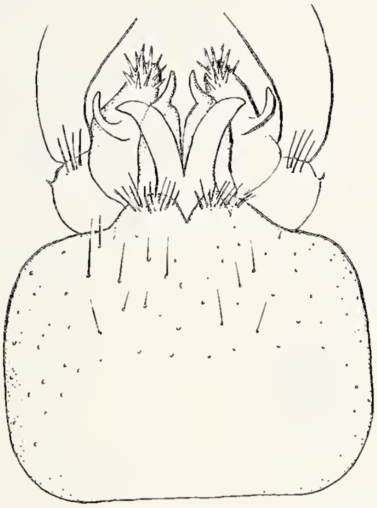

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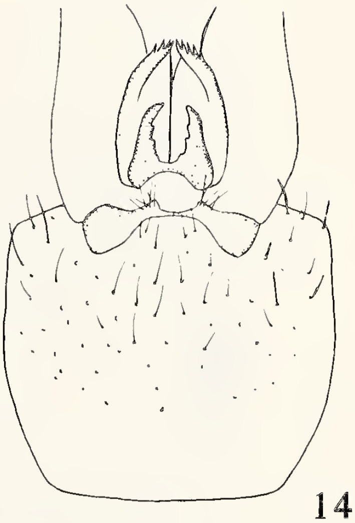

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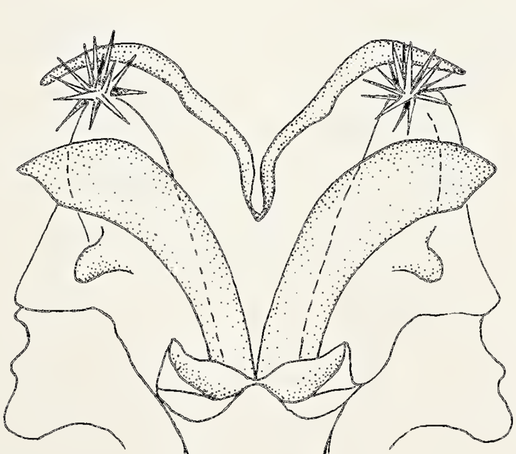

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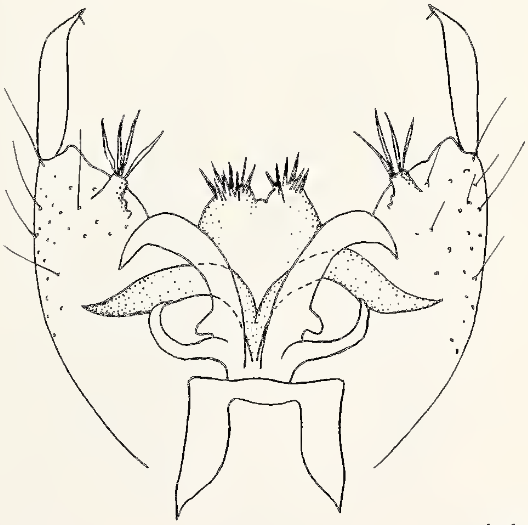
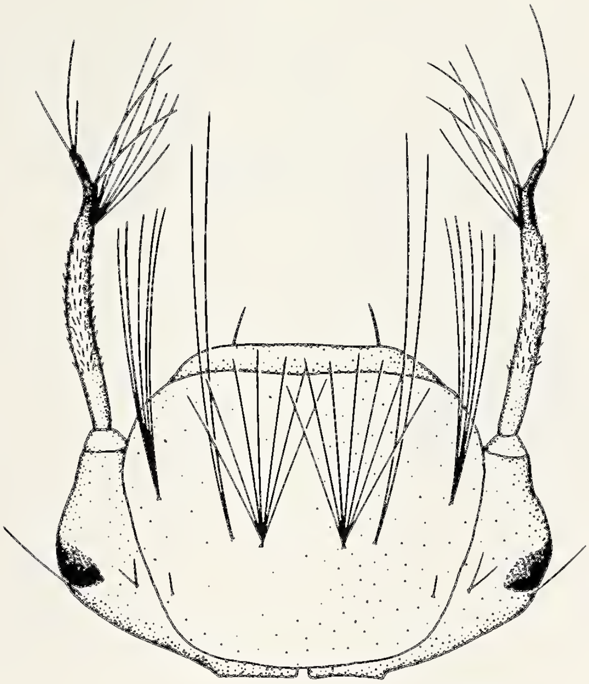


143

PLATE XXVII *Culiseta* species, fourth instar larvae, head

Figure 144	***Culiseta minnesotae***
145	***Cs. inornata***
146	***Cs. impatiens***
147	***Cs. melanura***
148	***Cs. morsitans***



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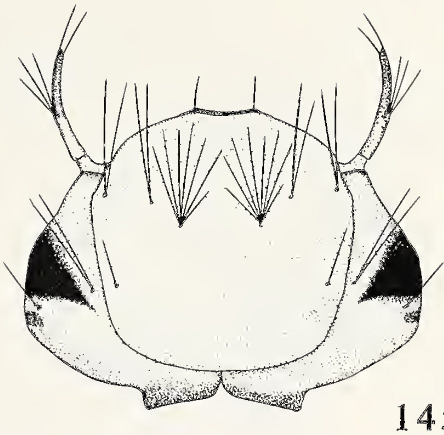

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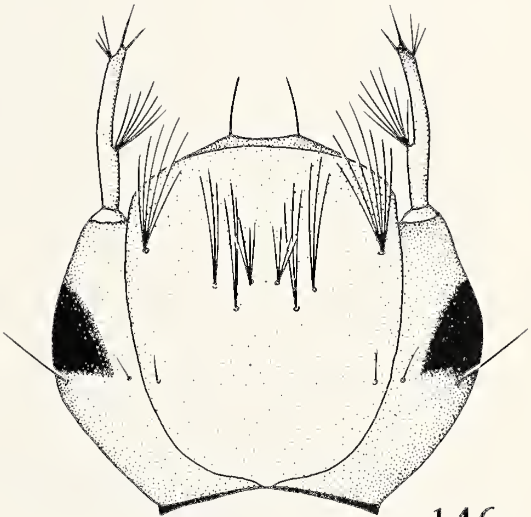

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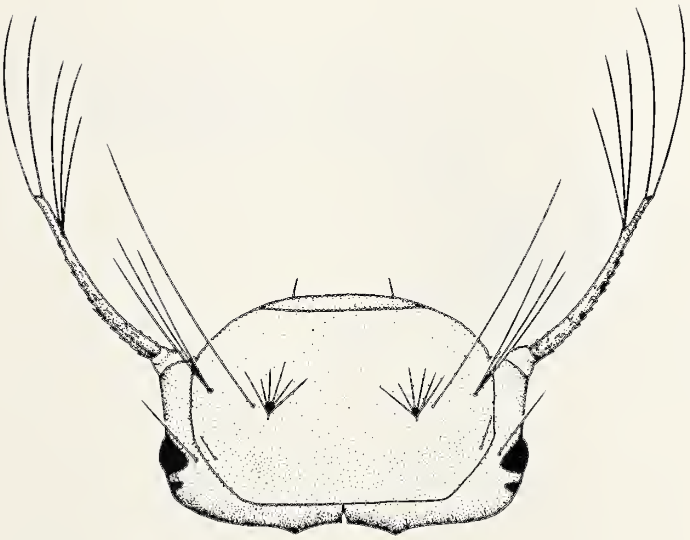

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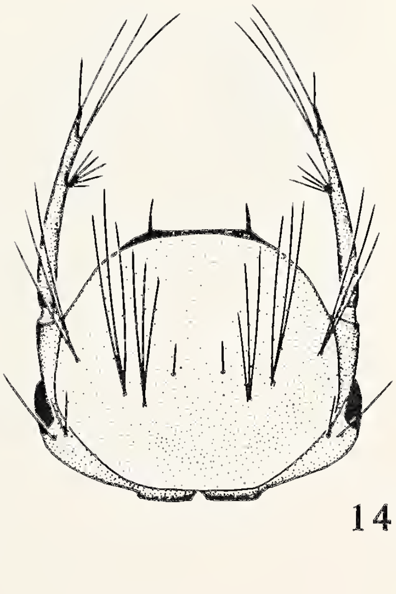

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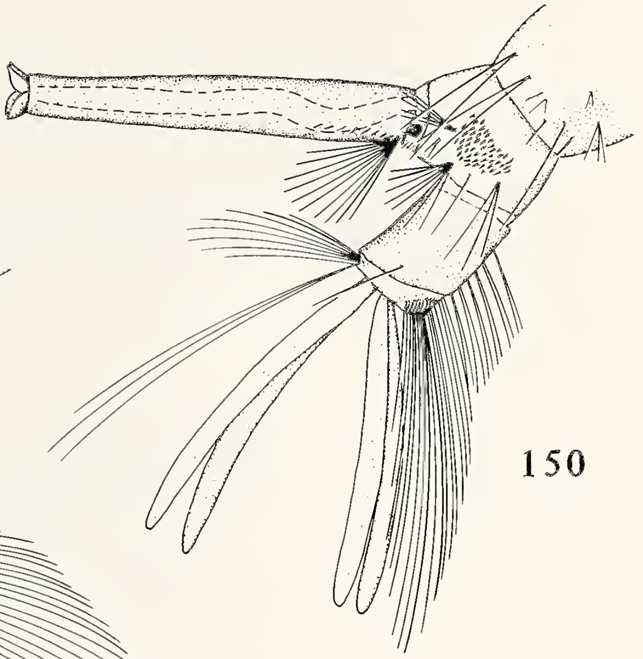
PLATE XXVIII *Culiseta* species, fourth instar larva, terminal segments

Figure 149 *Culiseta inornata*; a. comb scale
150 *Cs. minnesotae*
151 *Cs. melanura*; a. comb scale
152 *Cs. impatiens*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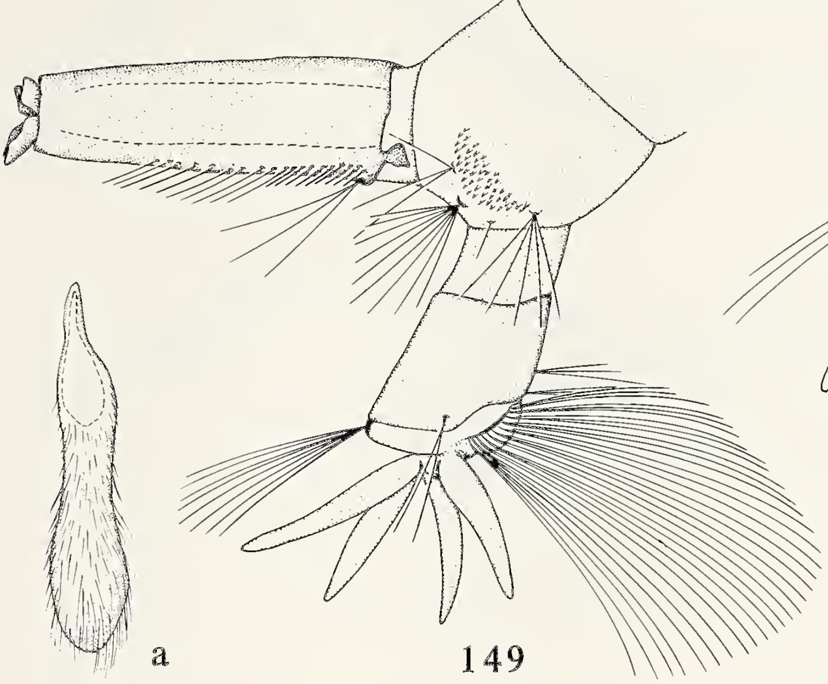

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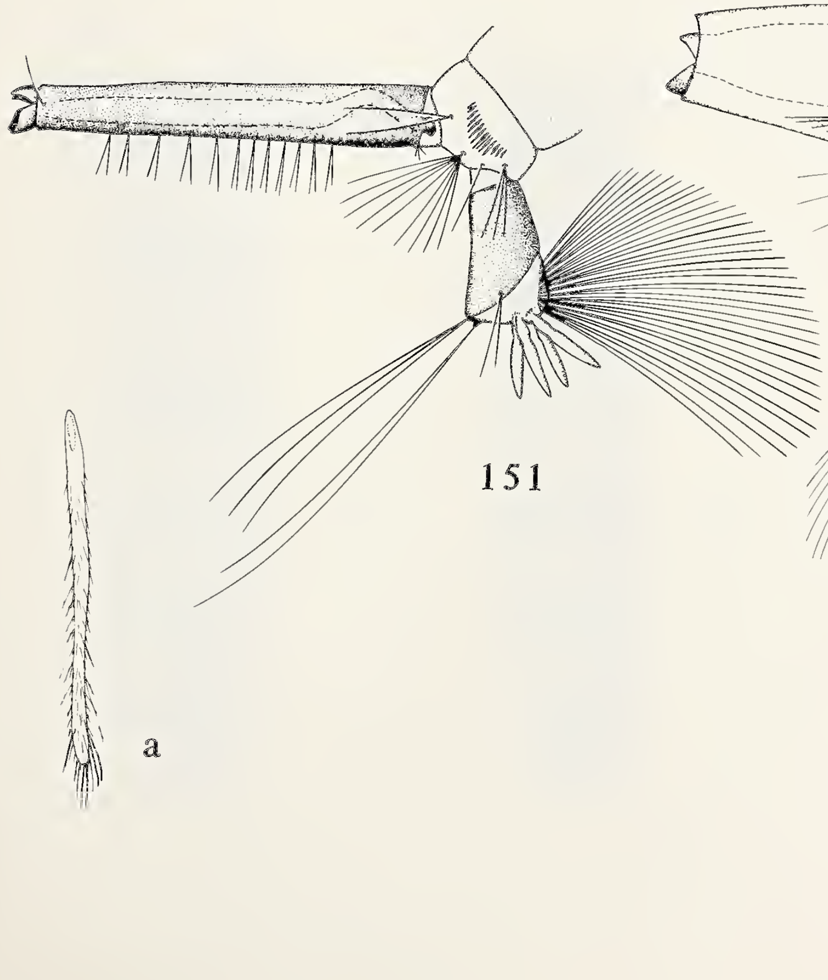

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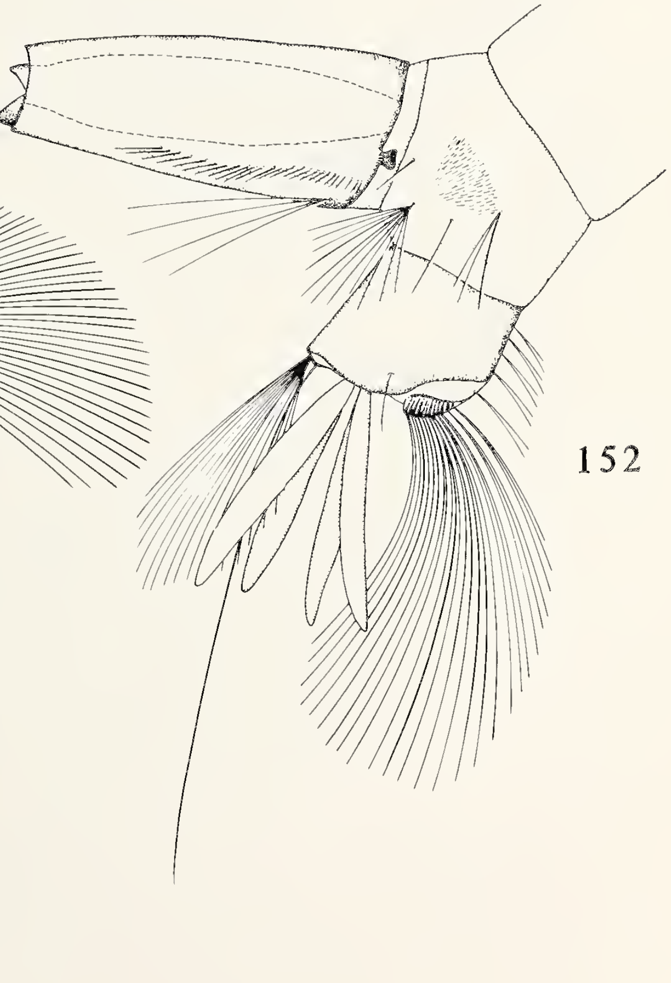
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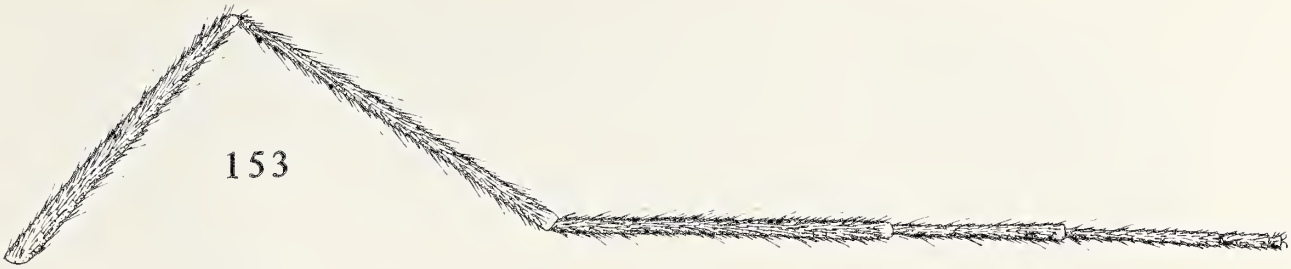
PLATE XXIX *Culiseta* species, adult female

Figure 153	*Culiseta minnesotae*, hindleg
154	*Cs. melanura*, hindleg
155	*Cs. minnesotae*, abdomen, dorsal aspect
156	*Cs. morsitans*, abdomen, dorsal aspect
157	*Cs. morsitans*, thorax, lateral aspect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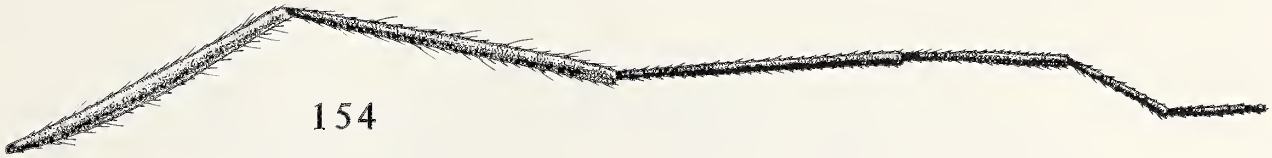
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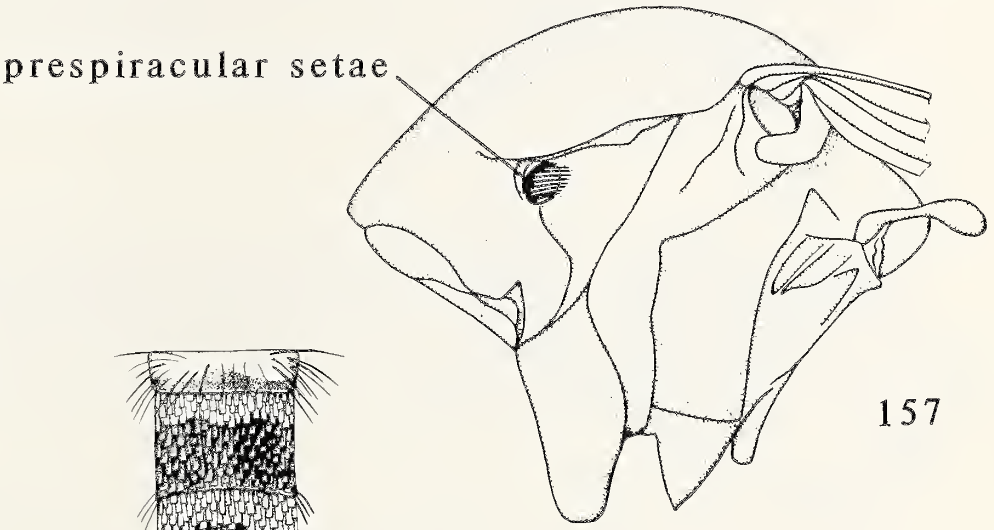

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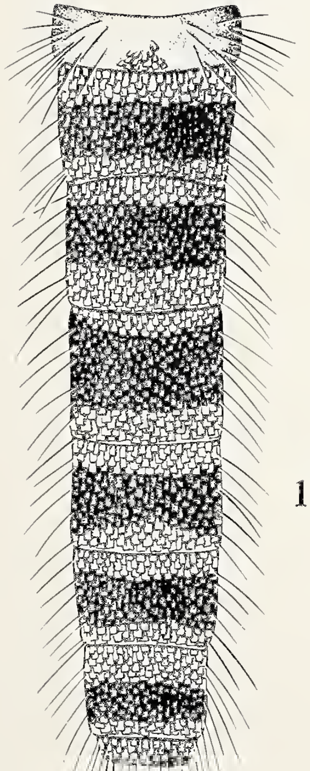
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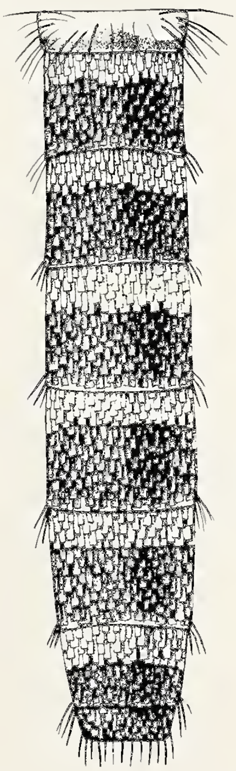
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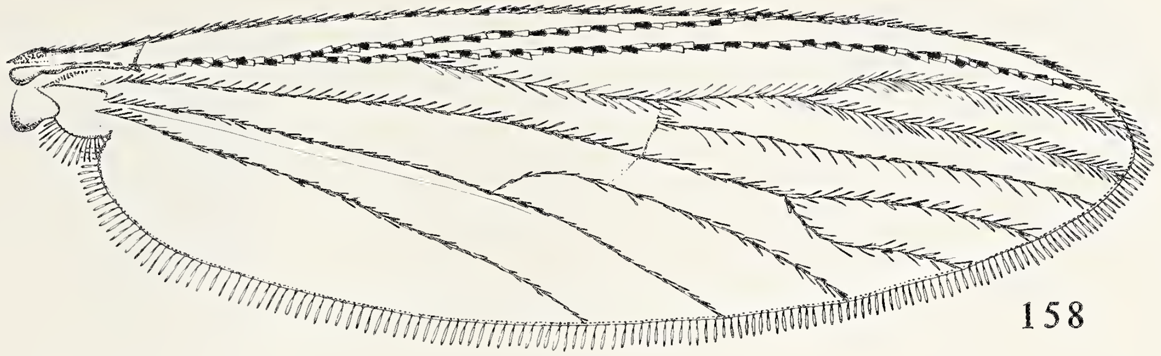
PLATE XXX	*Culiseta* species, wing
Figure 158	***Culiseta inornata***
159	***Cs. melanura***
160	***Cs. impatiens***
161	***Cs. melanura*, ventral aspect, subcostal setae**



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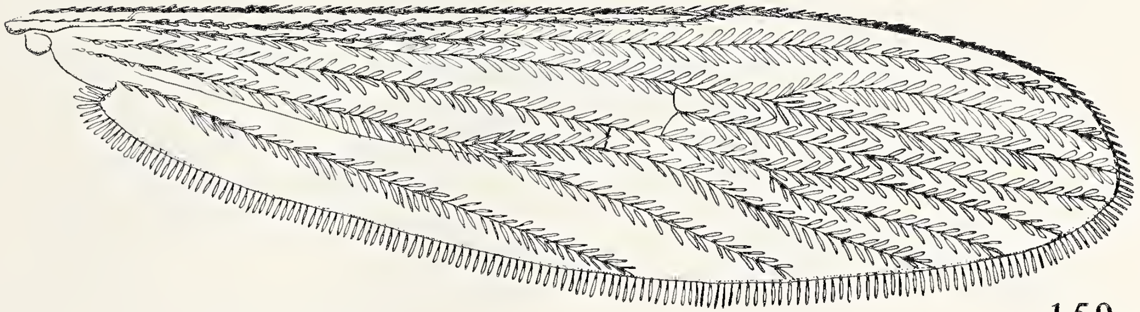

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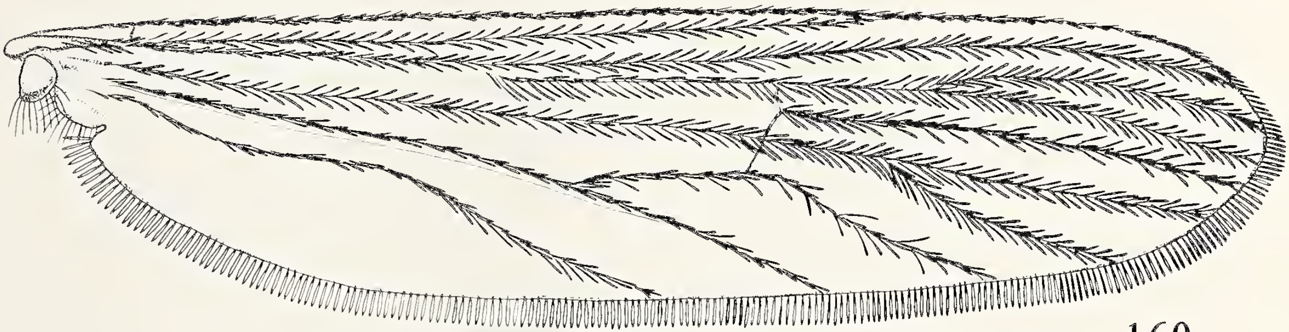

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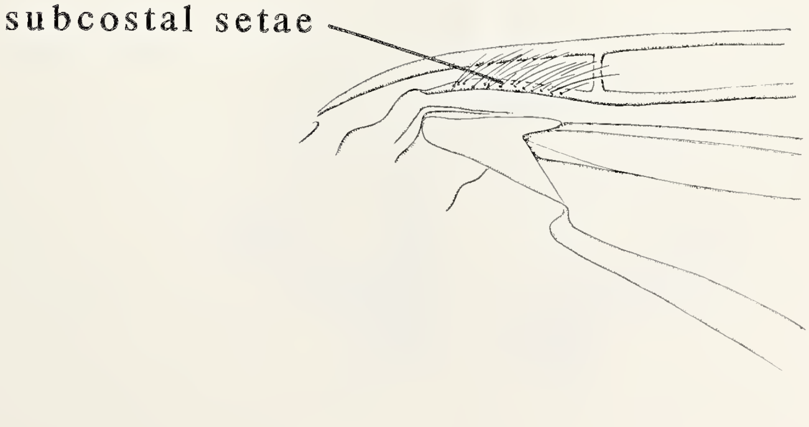

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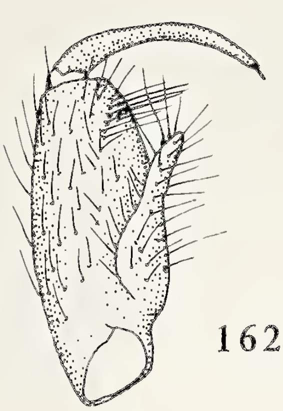
PLATE XXXI *Culiseta* species, male terminalia

Figure 162	*Culiseta impatiens*, basistyle
163	*Cs. morsitans*, phallosome
164	*Cs. minnesotae*, phallosome
165	*Cs. melanura*, phallosome
166	*Cs. inornata*, phallosome



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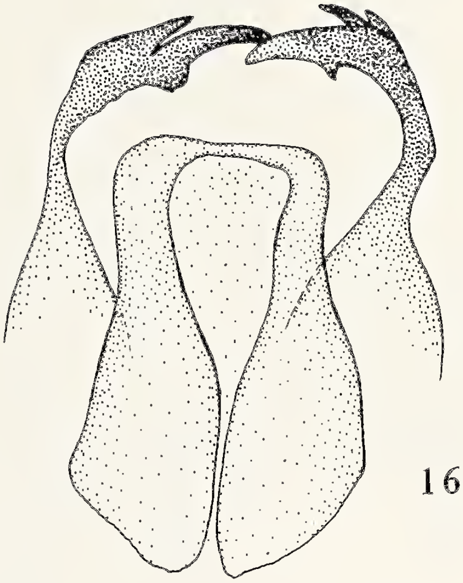

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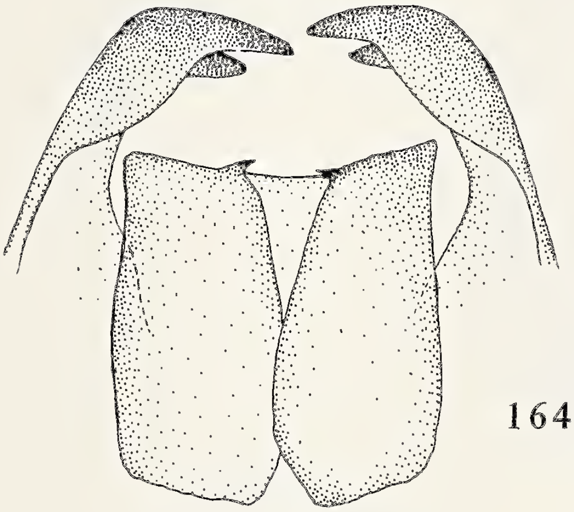

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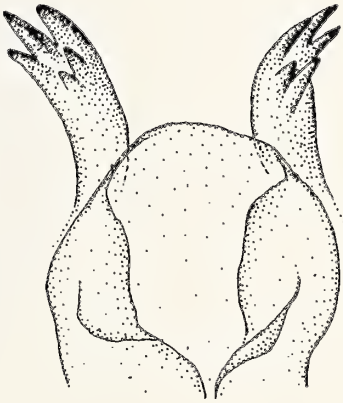

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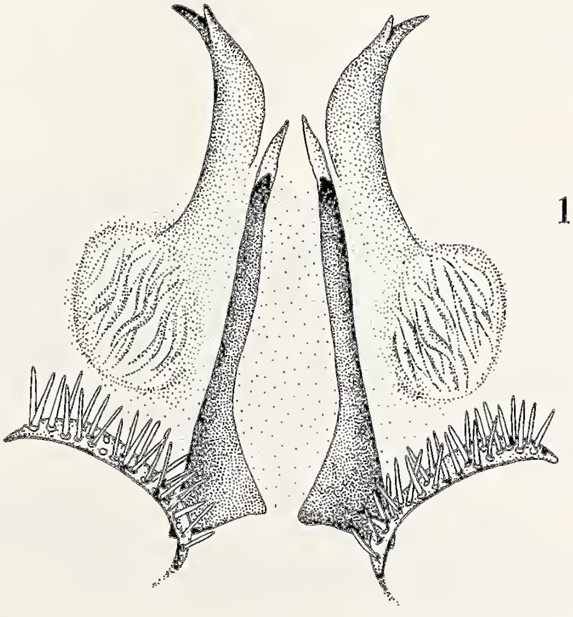
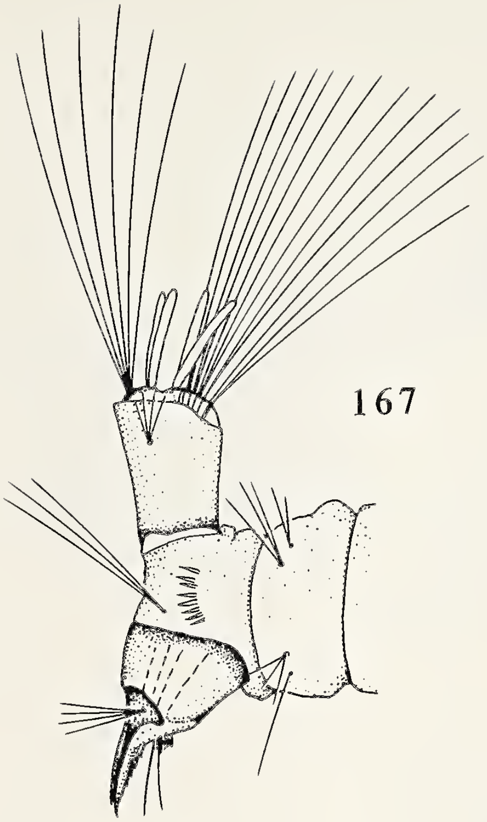


166

PLATE XXXII *Coquillettidia perturbans*

Figure 167	Fourth instar larva, terminal segments
168	Fourth instar larva, head
169	Adult female, mesonotum
170	Adult female, hindleg
171	Adult female, wing



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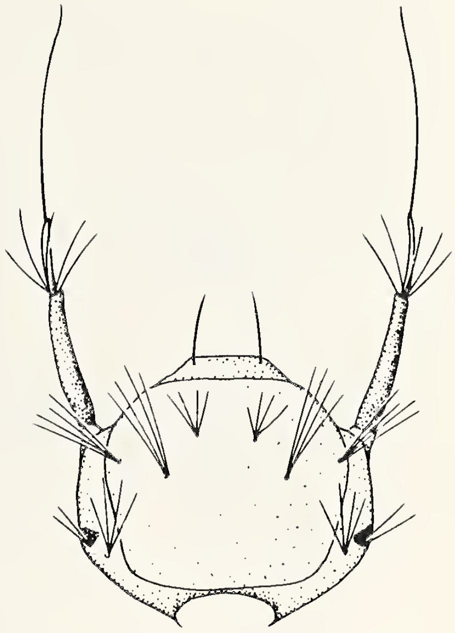

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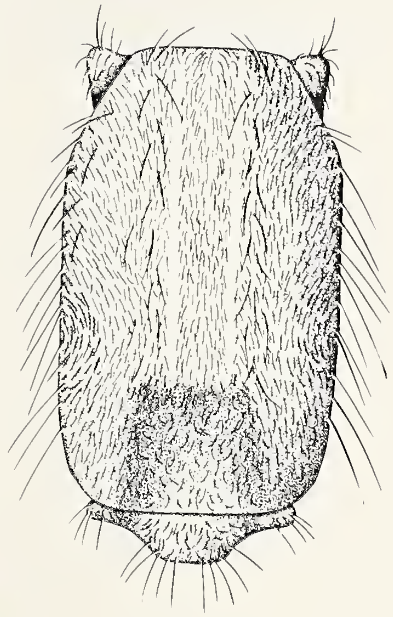

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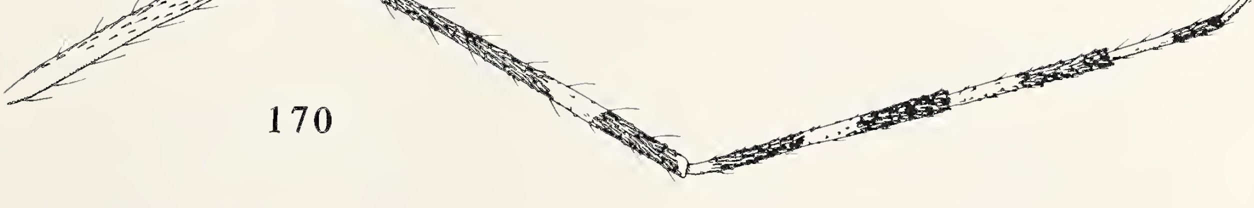

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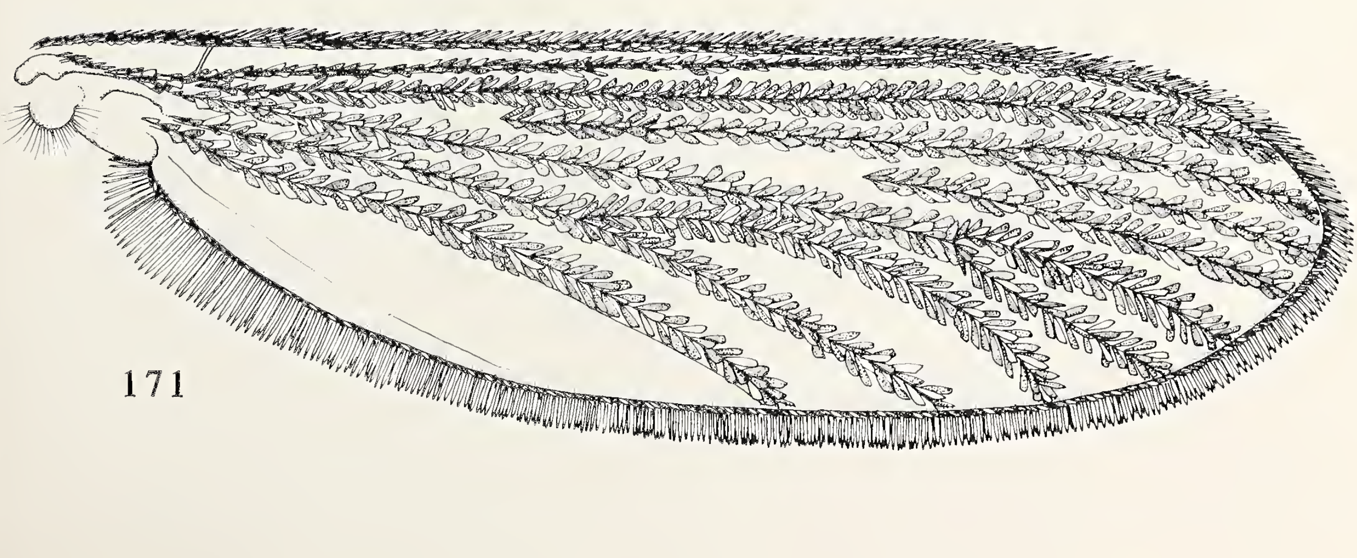
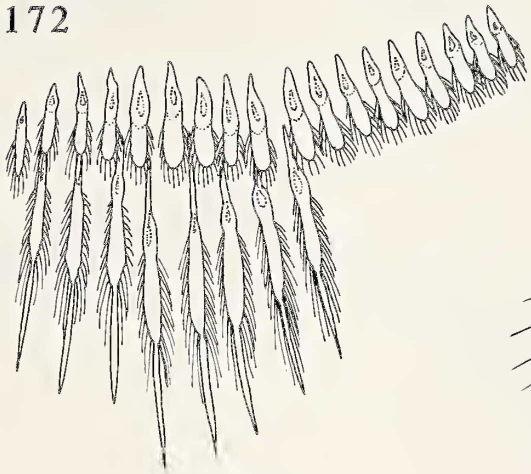


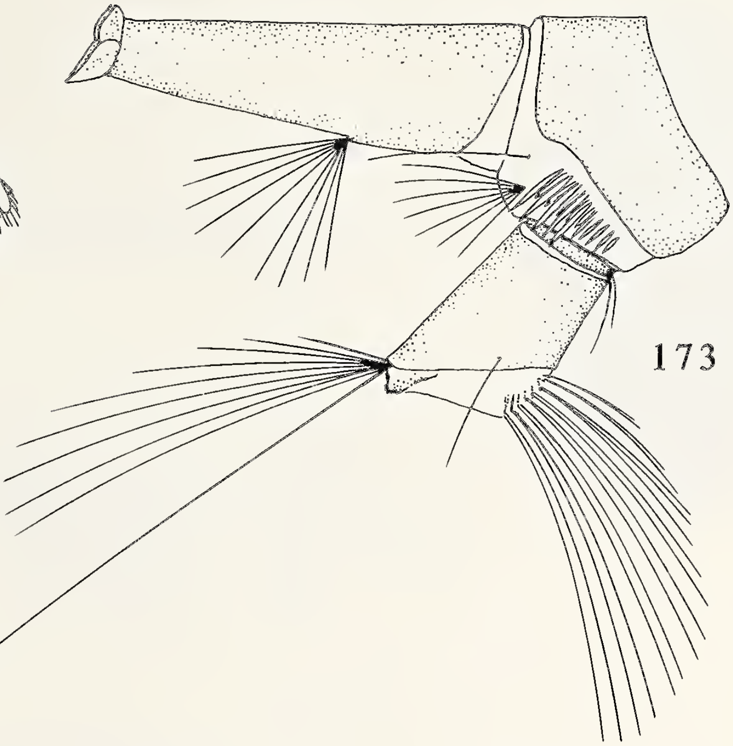
171

PLATE XXXIII *Orthopodomyia* species, larva

Figure 172	*Orthopodomyia signifera*, comb scales
173	*Or. signifera*, terminal segments
174	*Or. alba*, head
175	*Or. alba*, terminal segments, third instar

172





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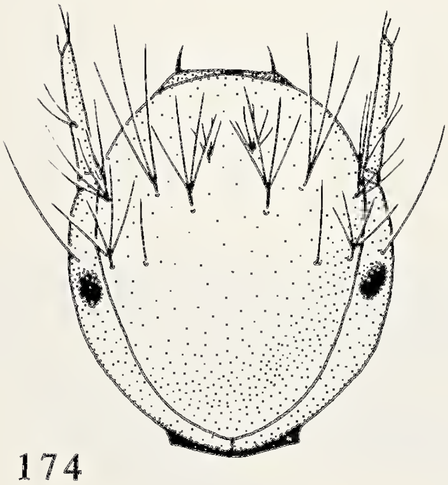

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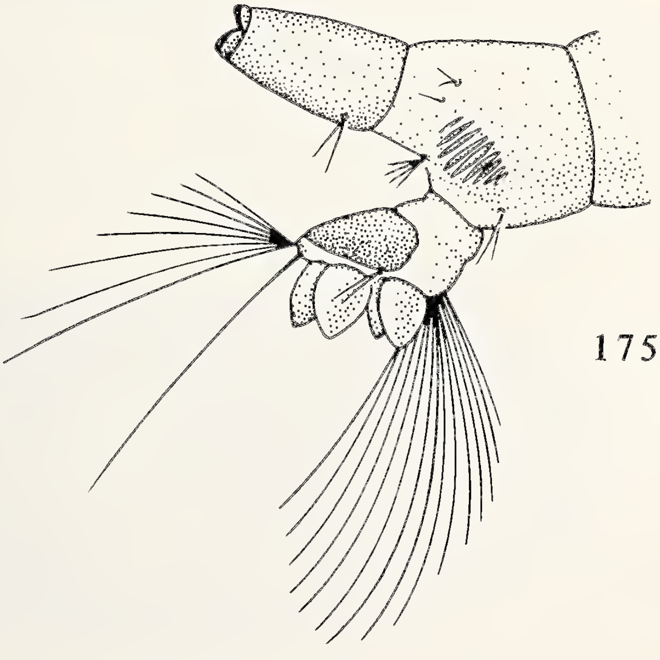

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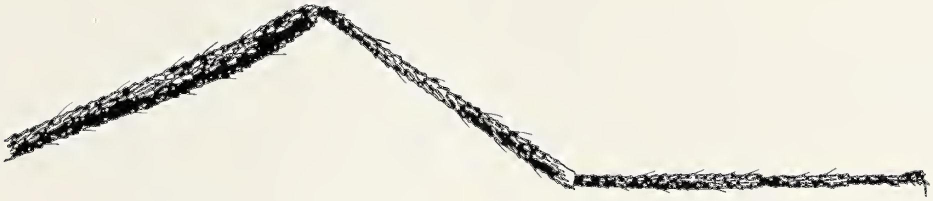
PLATE XXXIV *Orthopodomyia* species, adult female

Figure 176	*Orthopodomyia alba*, midtarsus
177	*Or. signifera*, midtarsus
178	*Or. alba*, hindtarsus
179	*Or. signifera*, hindtarsus
180	*Or. alba*, mesonotum
181	*Or. signifera*, wing



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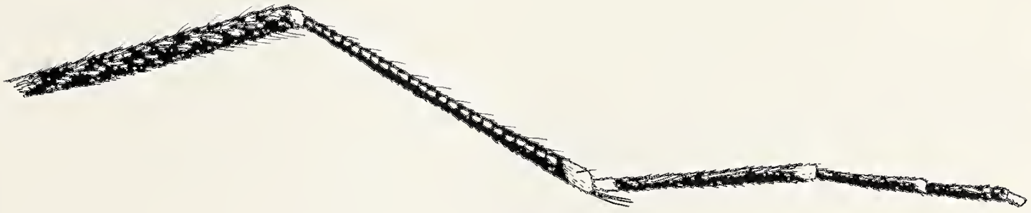

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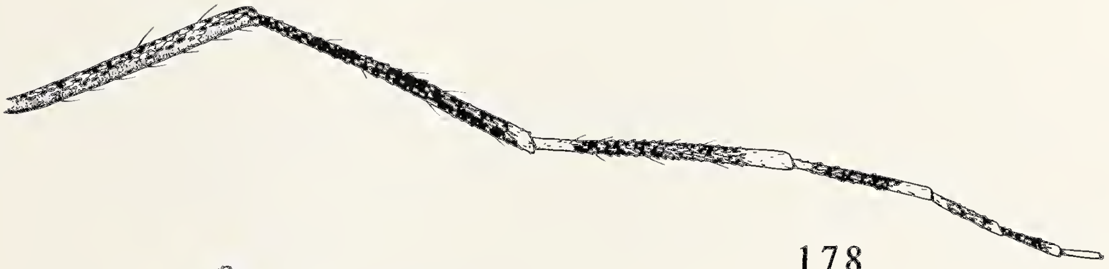

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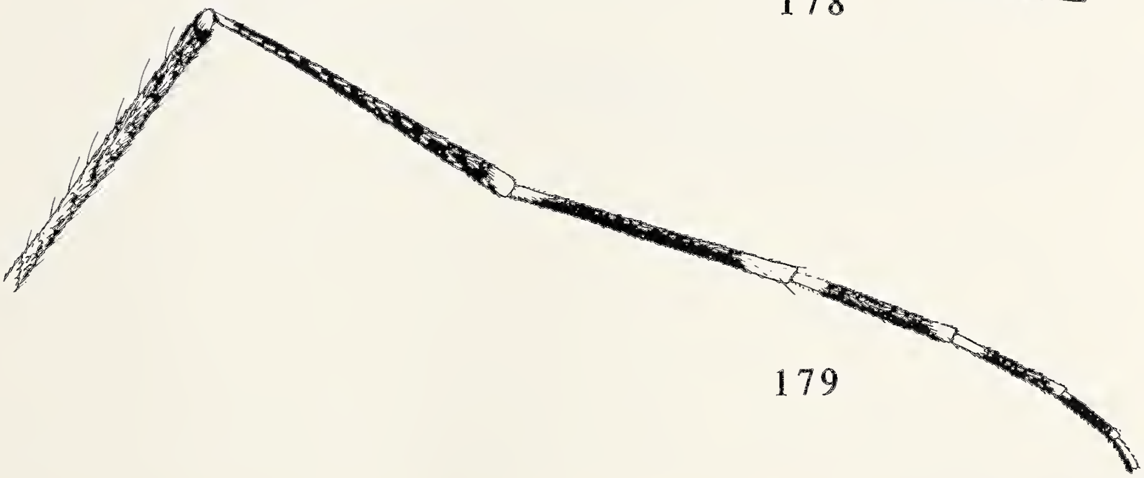

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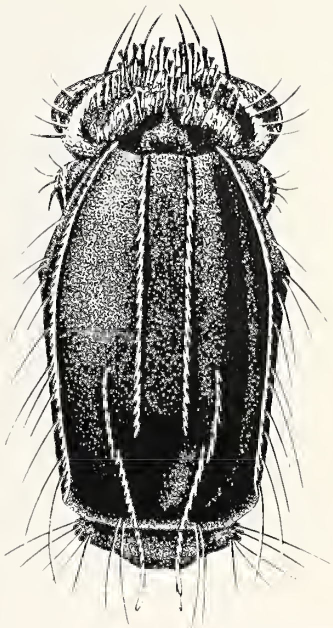

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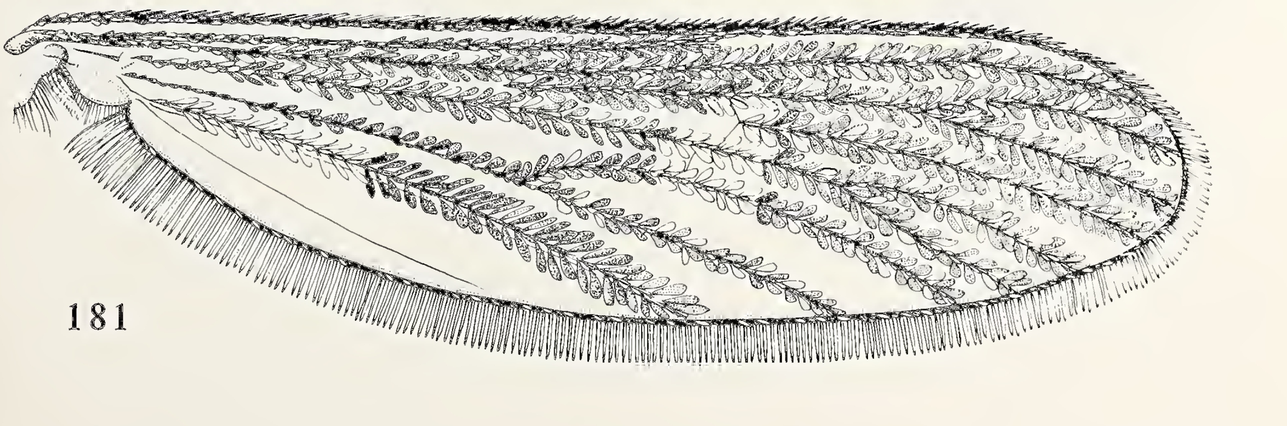

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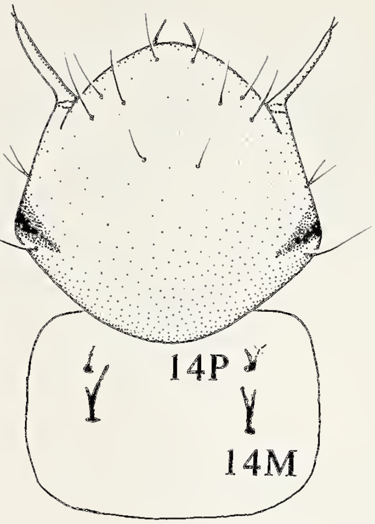
PLATE XXXV *Wyeomyia* species

Figure 182 *Wyeomyia smithii*, fourth instar larva, head
183 *Wy. smithii*, fourth instar larva, terminal segments
184 *Wy. smithii*, adult female, wing
185 *Wy. smithii*, adult female, lateral aspect of abdomen
186 *Wy. haynei*, adult female, scutellum and postnotum



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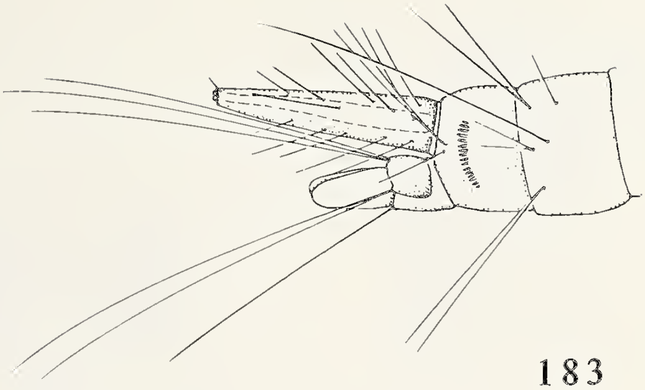

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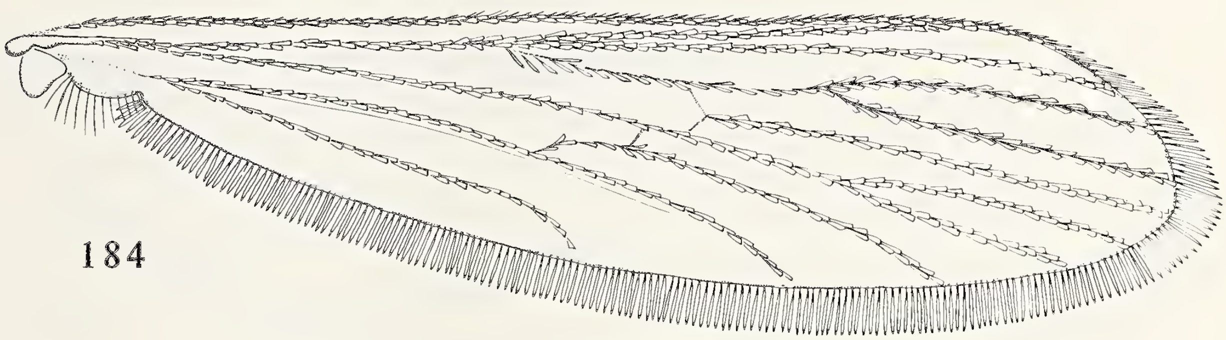

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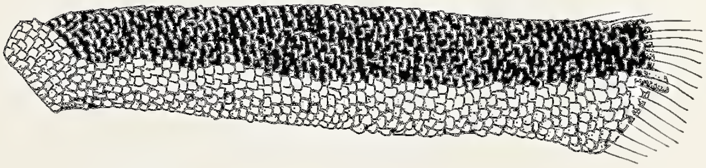

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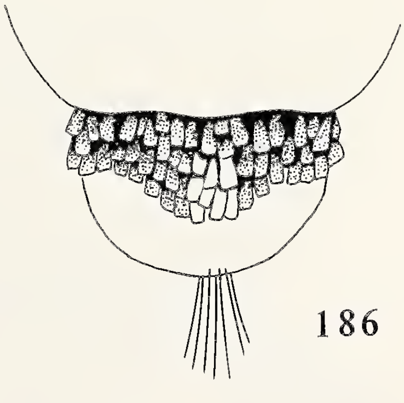

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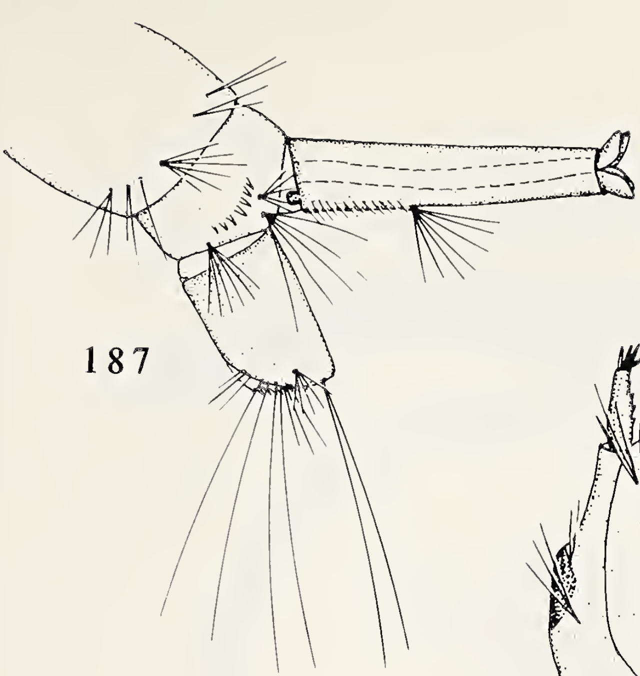
PLATE XXXVI *Uranotaenia sapphirina, Toxorhynchites rutilus septentrionalis*

Figure 187 *Uranotaenia sapphirina*, fourth instar larva, terminal segments
188 *Ur. sapphirina*, fourth instar larva, head
189 *Ur. sapphirina*, adult female, mesonotum
190 *Ur. sapphirina*, wing
191 *Toxorhynchites rutilus septentrionalis*, fourth instar larva, head
192 *Tx. rutilus septentrionalis*, fourth instar larva, terminal segments



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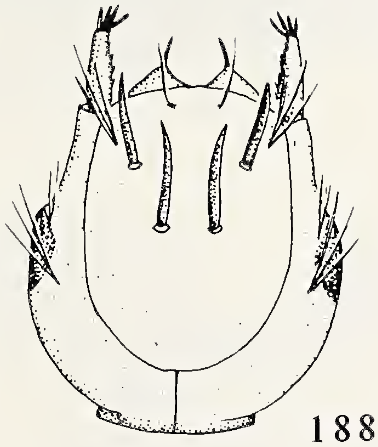

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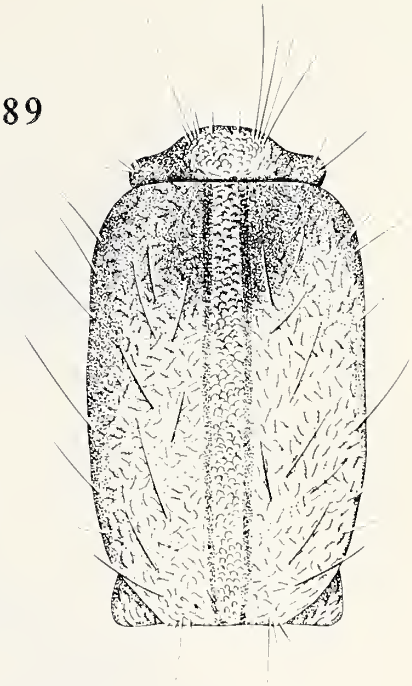

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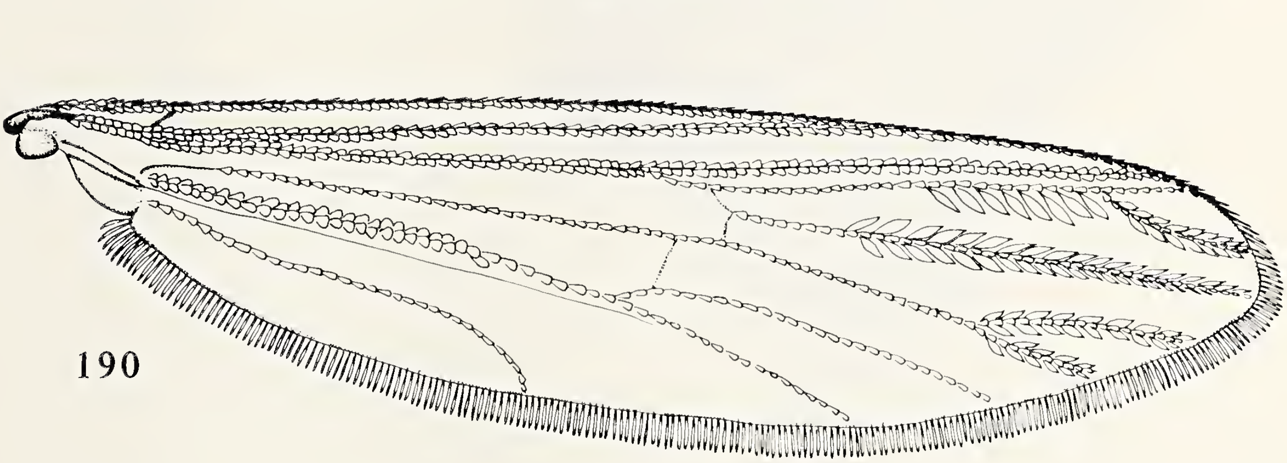

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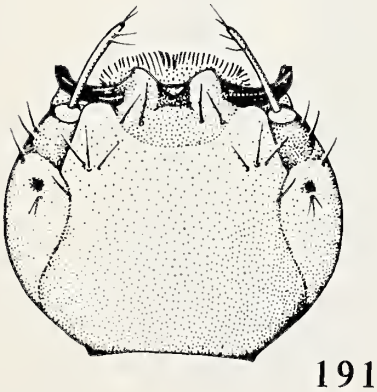

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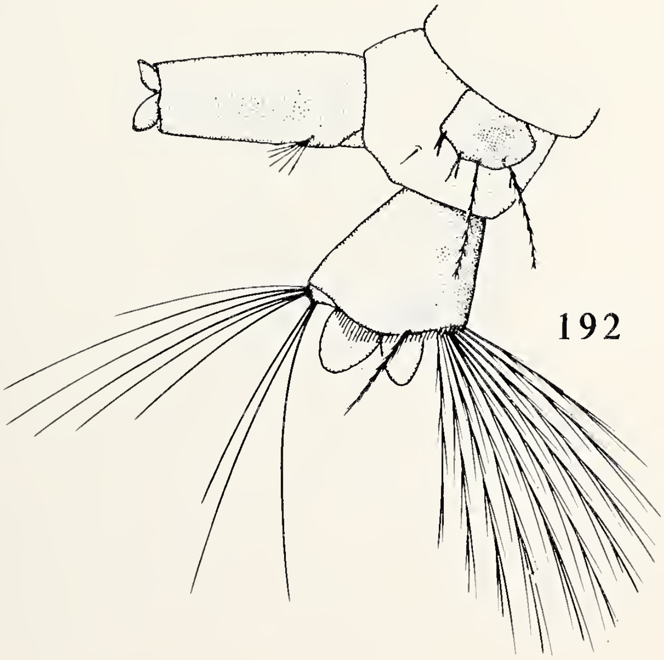
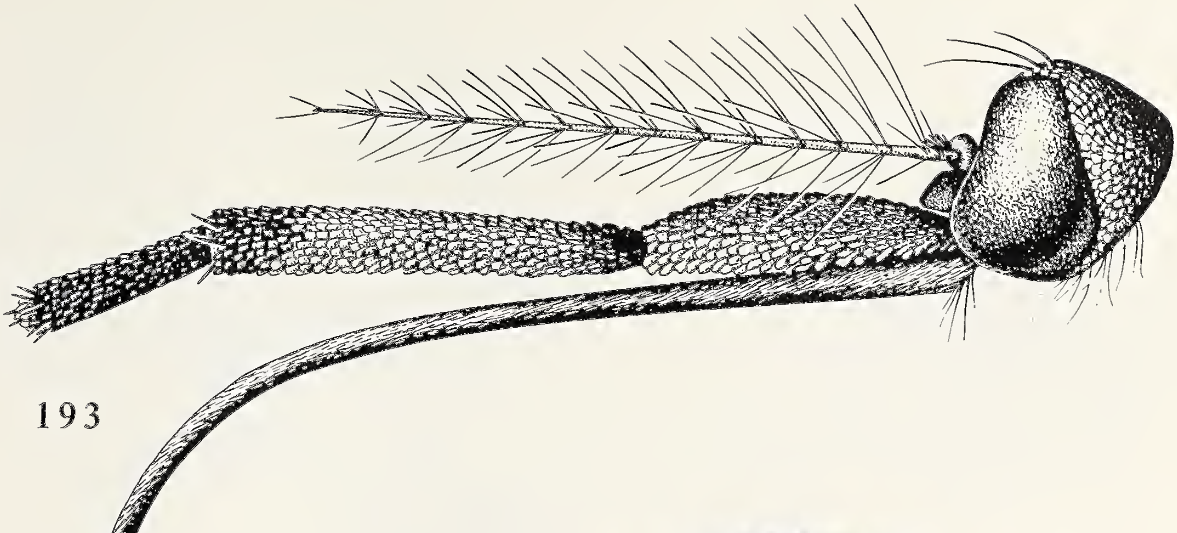


192

PLATE XXXVII	*Toxorhynchites rutilus septentrionalis*
Figure 193	Adult female, head, lateral aspect
194	Adult female, thorax, lateral aspect
195	Adult female, mesonotum
196	Male terminalia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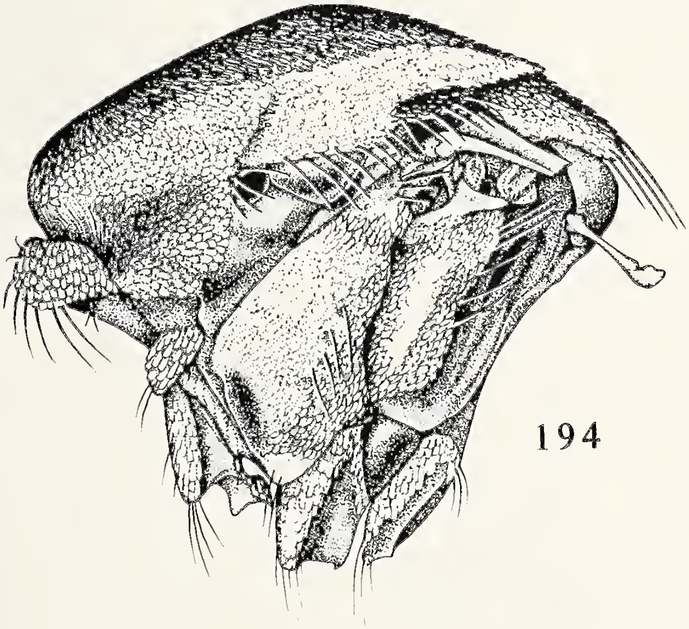
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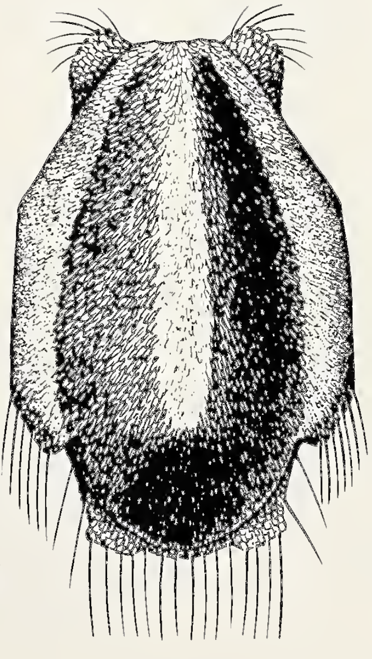
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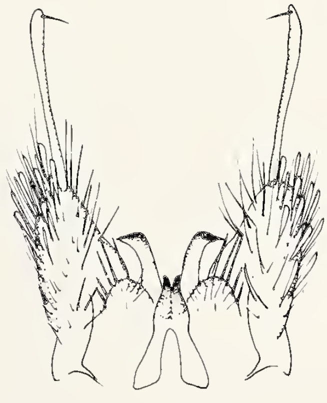
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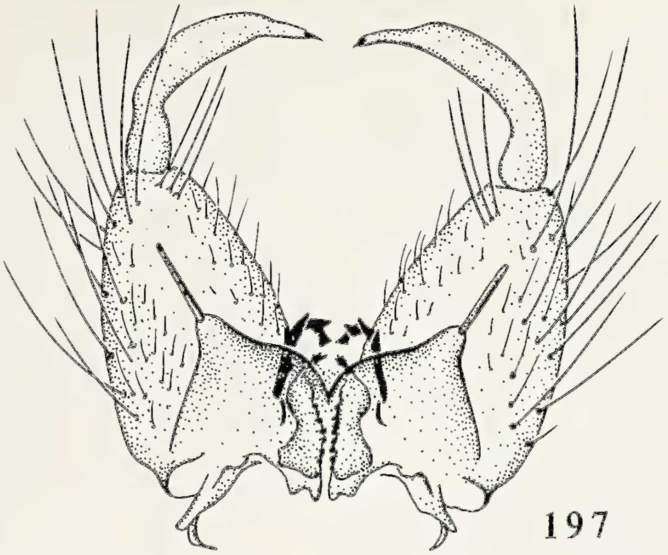
PLATE XXXVIII	Male Terminalia
Figure 197	*Coquillettidia perturbans*
198	*Uranotaenia sapphirina*
199	*Wyeomyia smithii*
200	*Orthopodomyia alba*
201	*Anopheles quadrimaculatus*
202	*Aedes abserratus*
203	*Aedes aegypti*, diststyle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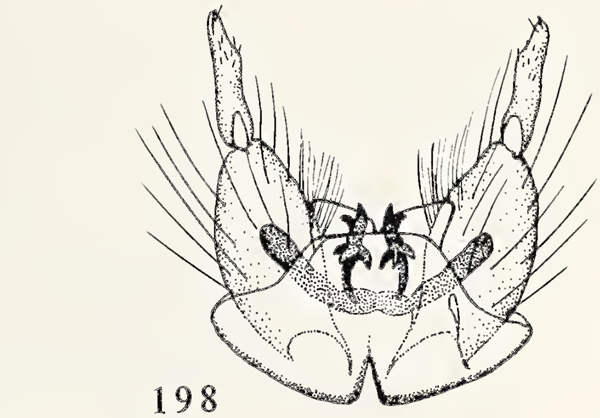
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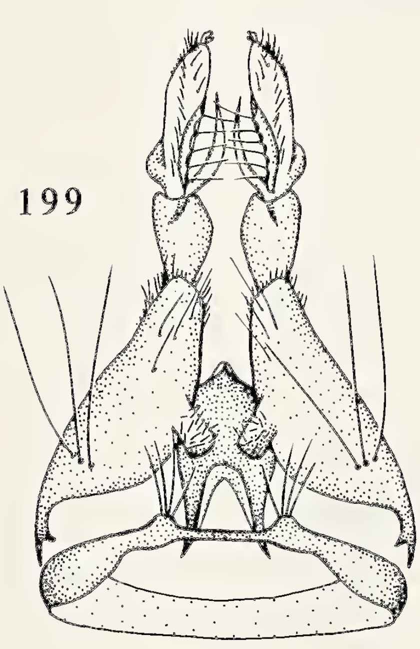
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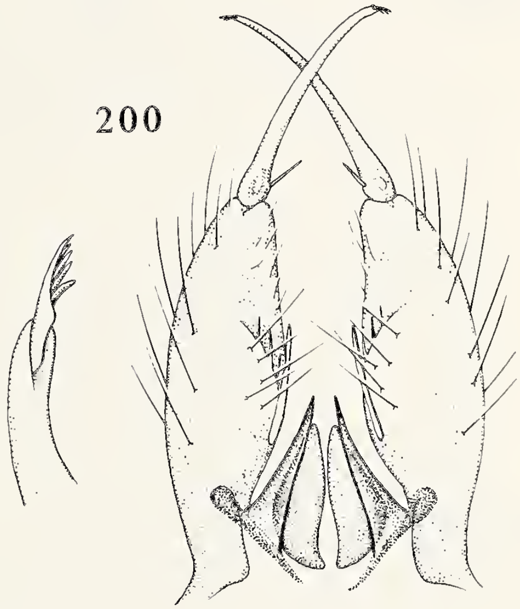
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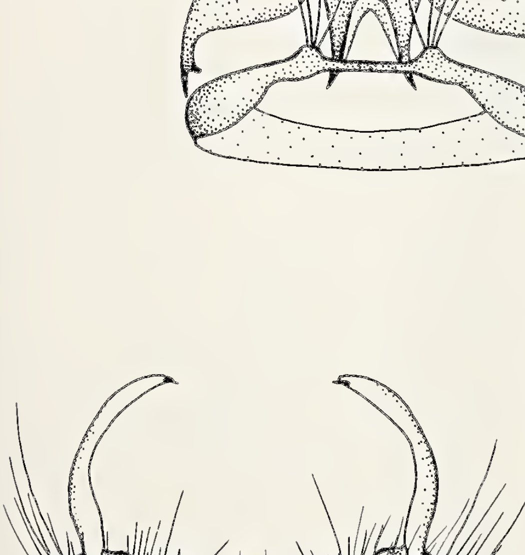
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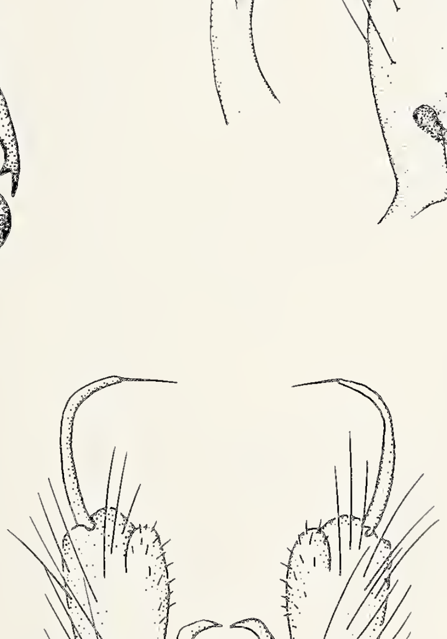
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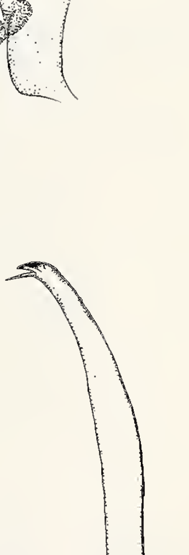
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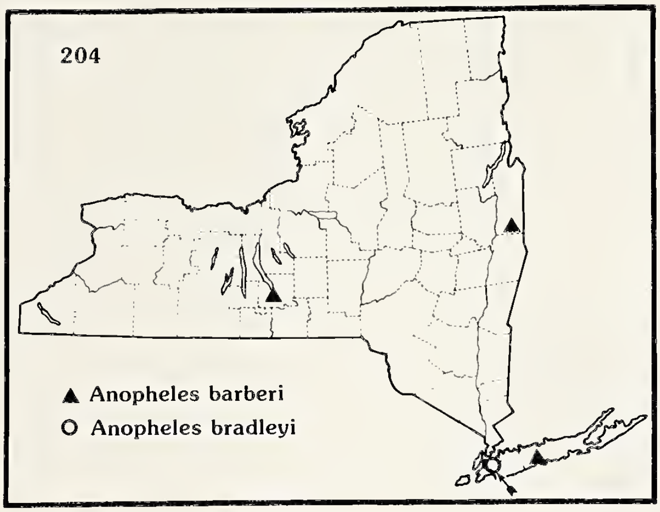
PLATE XXXIX	**Distribution Maps**
Figure 204	*Anopheles barberi*, *An. bradleyi*
205	*An. crucians*
206	*An. earlei*
207	*An. punctipennis*
208	*An. quadrimaculatus*
209	*An. walkeri*

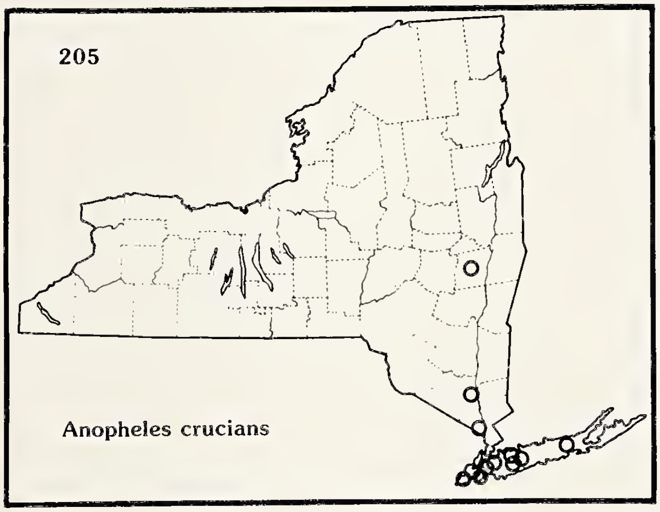
204



▲ Anopheles barberi

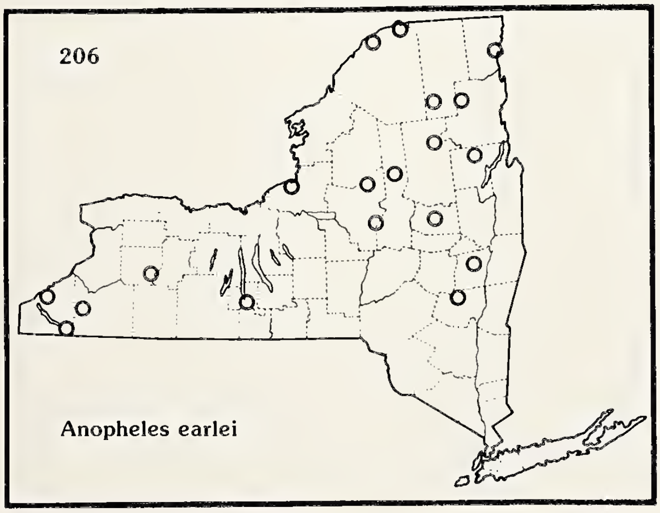
○ Anopheles bradleyi

205



Anopheles crucians

206



Anopheles earlei

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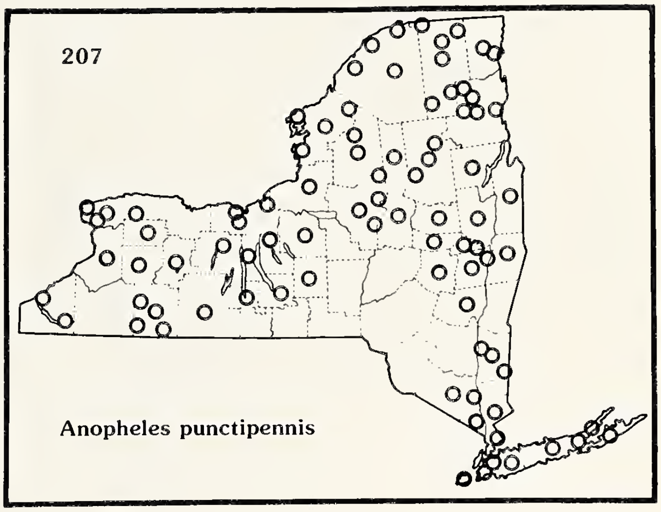

Anopheles punctipennis

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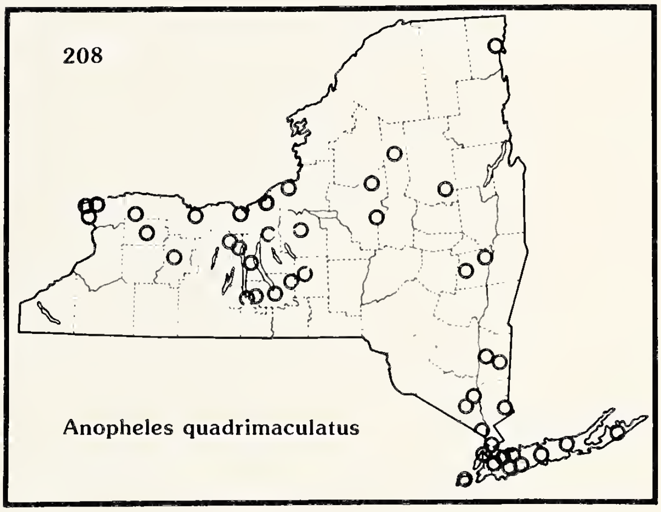

Anopheles quadrimaculatus

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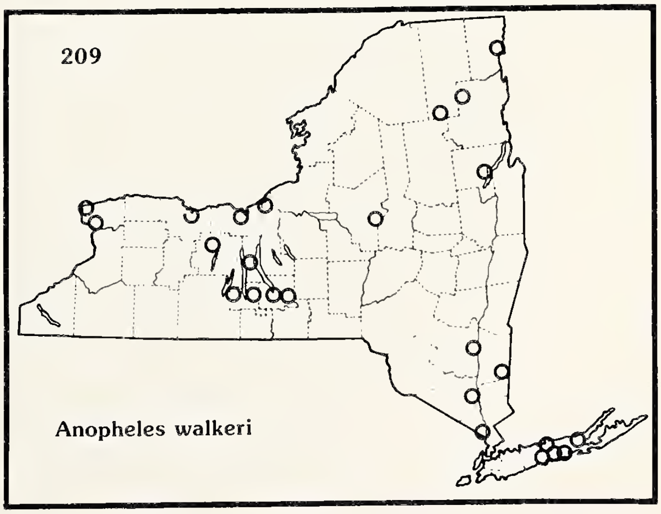
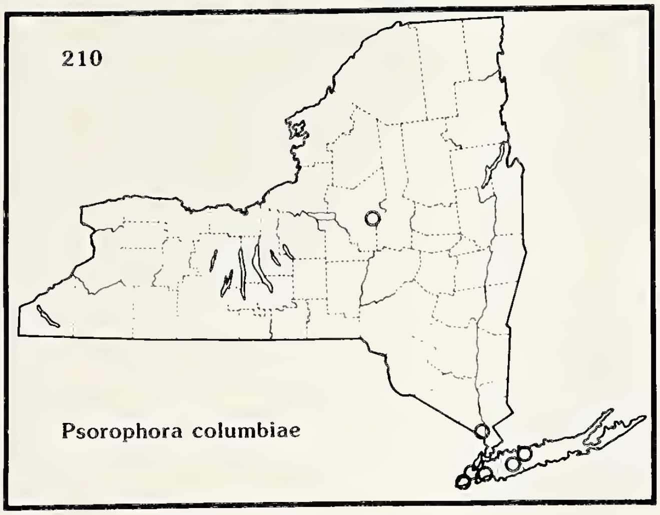


Anopheles walkeri

PLATE XXXX	**Distribution Maps**
Figure 210	*Psorophora columbiae*
211	*Ps. ferox*
212	*Ps. mathesoni*
213	*Ps. ciliata*
214	*Culex pipiens*
215	*Cx. restuans*



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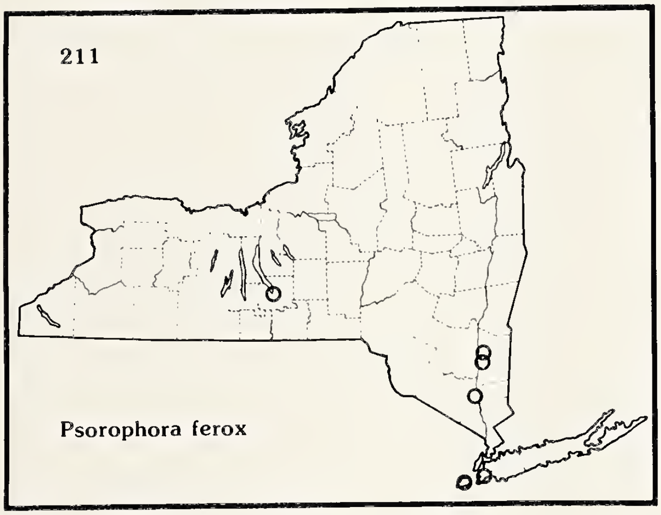
Psorophora columbiae



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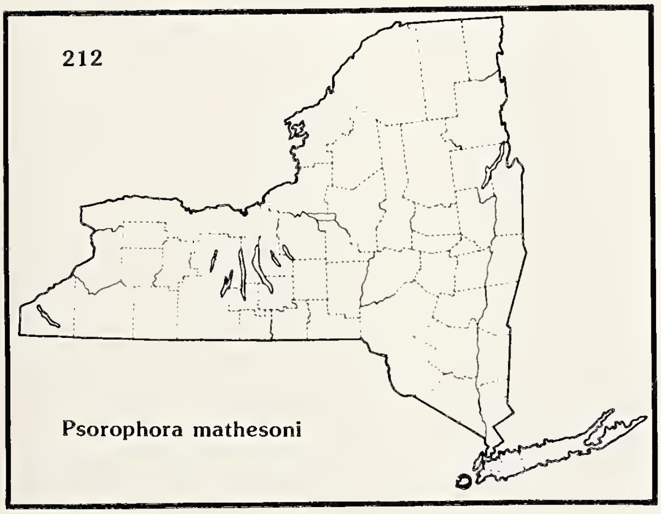
Psorophora ferox



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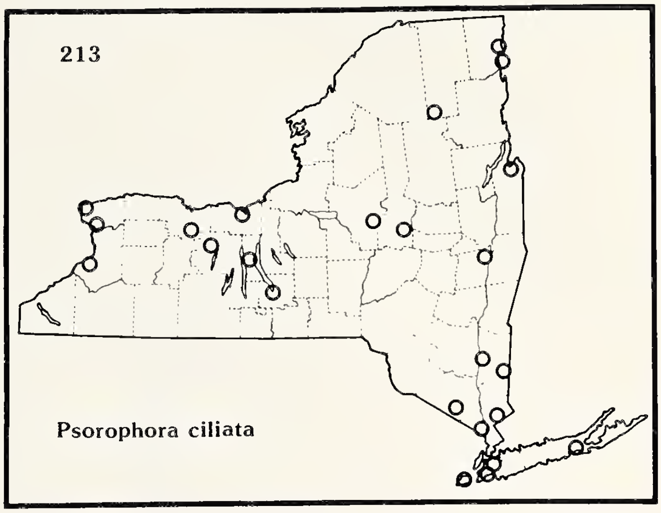
Psorophora mathesoni



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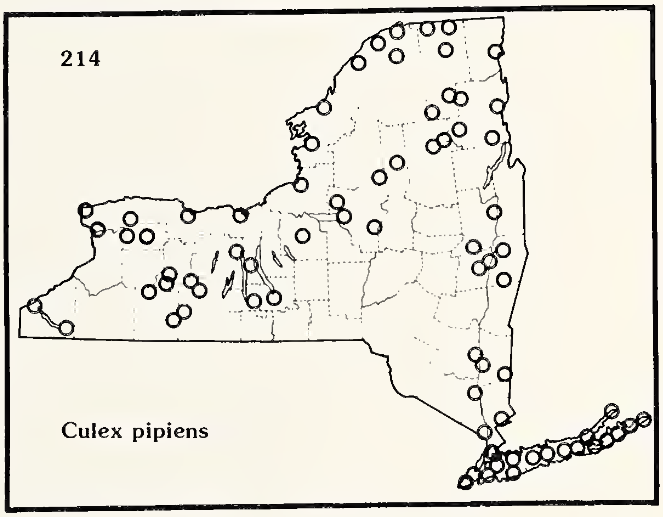
Psorophora ciliata



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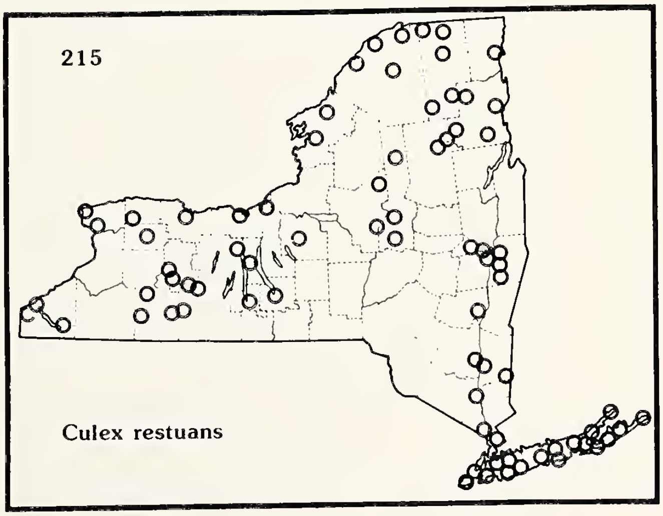
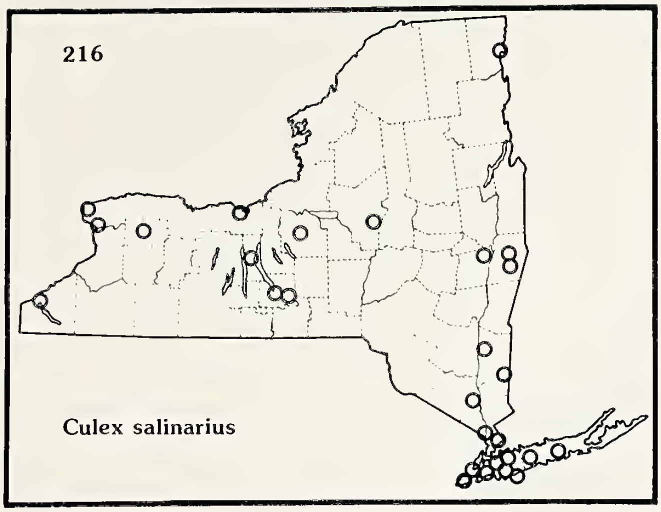
Culex pipiens



215

Culex restuans

PLATE XXXXI	**Distribution Maps**
Figure 216	***Culex salinarius***
217	***Cx. territans***
218	***Culiseta melanura***
219	***Cs. morsitans***
220	***Cs. minnesotae***
221	***Cs. impatiens***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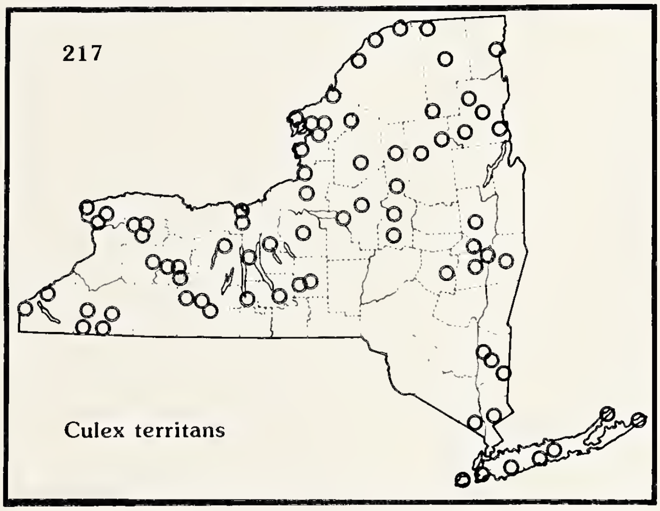
Culex salinarius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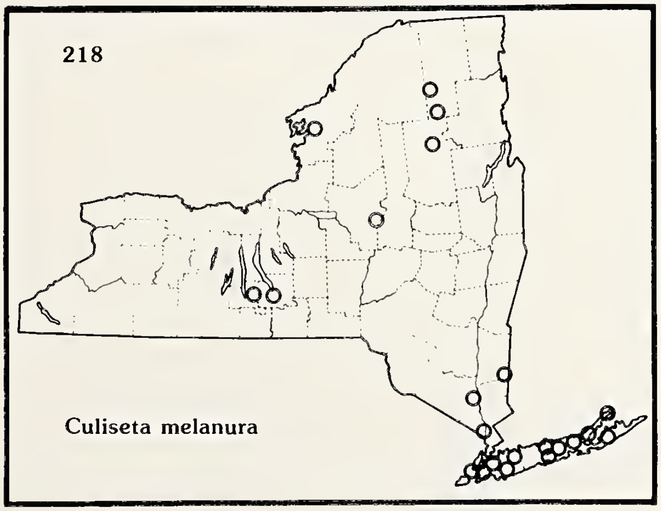
Culex territans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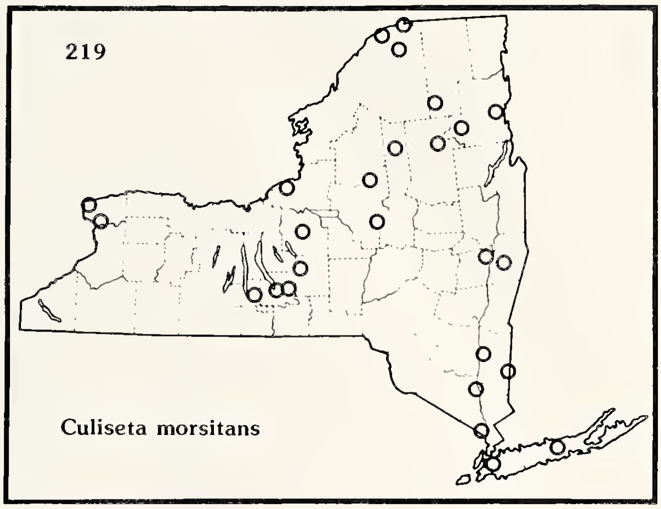
Culiseta melanura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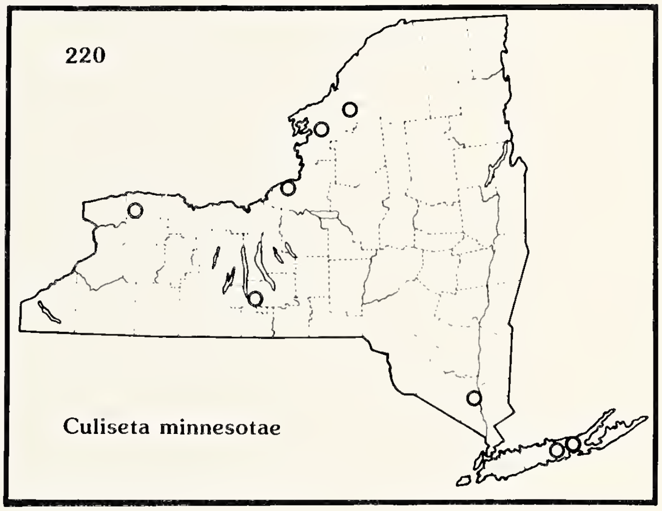
Culiseta morsitans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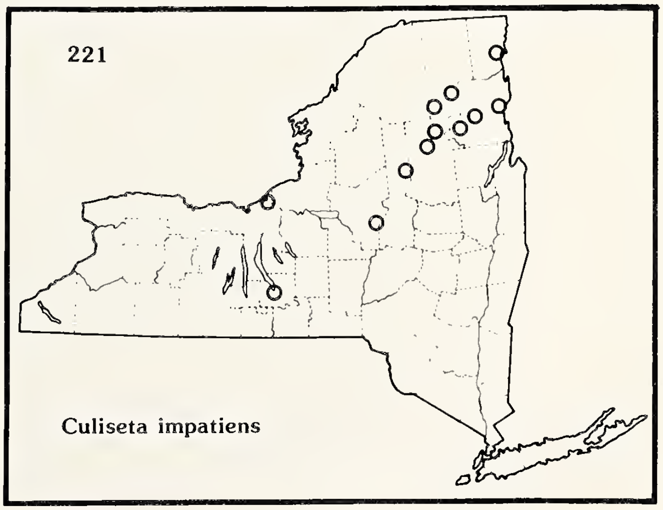
Culiseta minnesotae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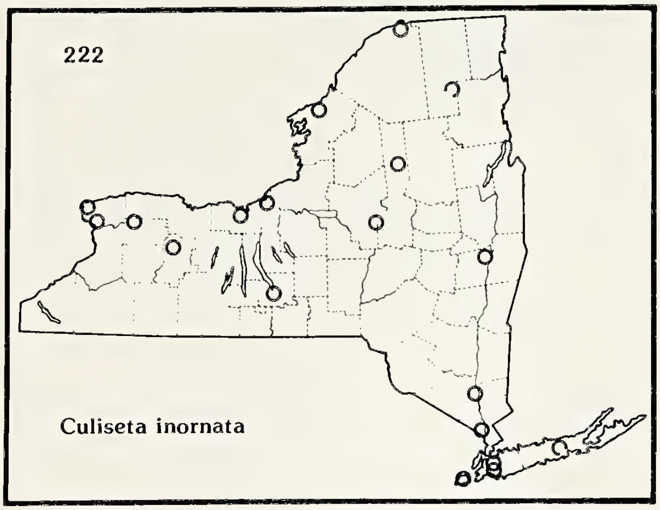
Culiseta impatiens

PLATE XXXXII	**Distribution Maps**
Figure 222	*Culiseta inornata*
223	*Coquillettidia perturbans*
224	*Orthopodomyia alba, Or. signifera*
225	*Wyeomyia smithii*
226	*Uranotaenia sapphirina*
227	*Toxorhynchites rutilus septentrionalis*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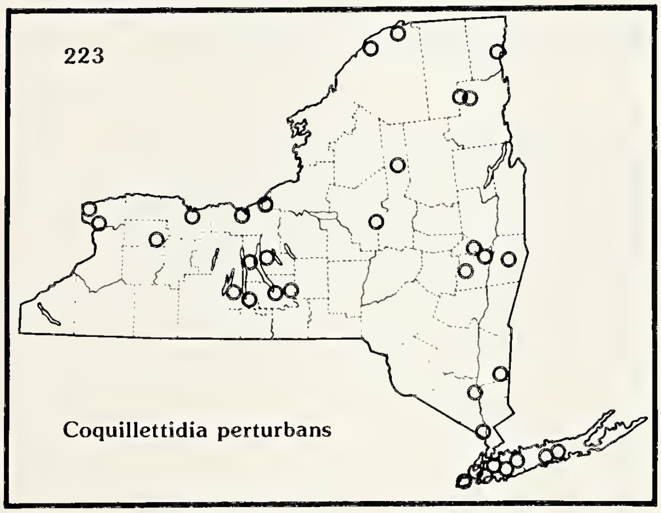
Culiseta inornata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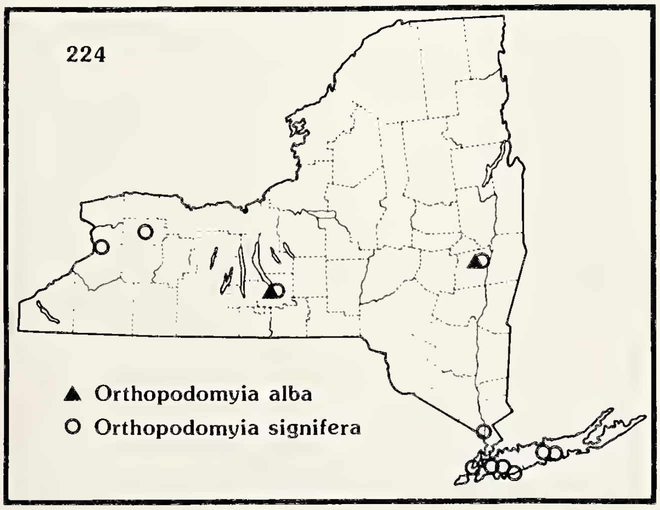
Coquillettidia perturbans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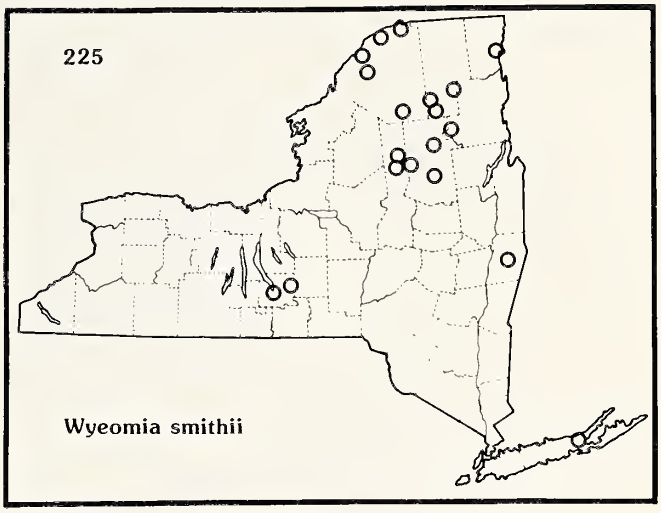
▲ Orthopodomyia alba
○ Orthopodomyia signifera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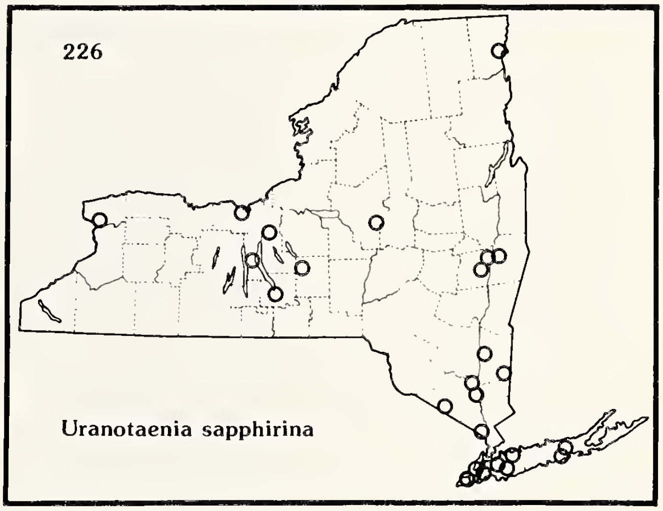
Wyeomia smithii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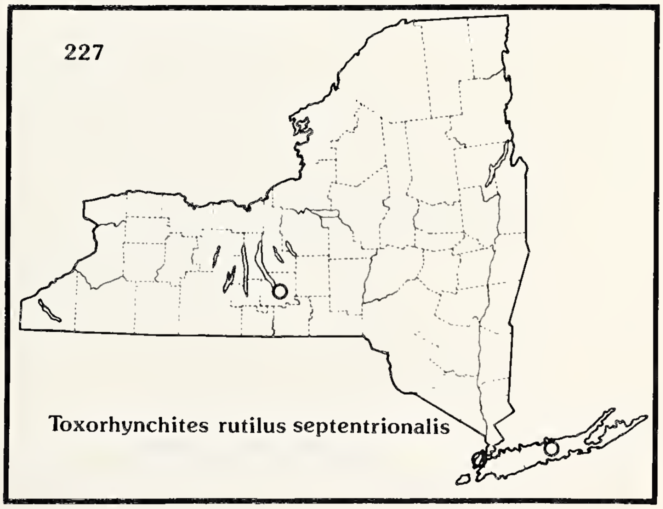
Uranotaenia sapphirina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Toxorhynchites rutilus septentrionalis

APPENDIX

MOSQUITOES (CULICIDAE) REPORTED FROM NEW YORK STATE (REVISED)

Subfamily ANOPHELINAE

- *Anopheles* (*Anopheles*) *barberi* Coquillett
  - *bradleyi* King
  - *crucians* Wiedemann
  - *earlei* Vargas
  - *punctipennis* (Say)
  - *quadrimaculatus* Say
  - *walkeri* Theobald

Subfamily CULICINAE

Tribe AEDINI

- *Aedes* (*Aedes*) *cinereus* Meigen
  - (*Aedimorphus*) *vexans* (Meigen)
  - (*Ochlerotatus*) *abserratus* (Felt & Young)
    - *atlanticus* Dyar & Knab
    - *atropalpus* (Coquillett)
    - *aurifer* (Coquillett)
    - *canadensis* (Theobald)
    - *cantator* (Coquillett)
    - *caspius dorsalis* (Meigen)[1]
    - *communis* (DeGeer)
    - *decticus* Howard, Dyar & Knab
    - *diantaeus* Howard, Dyar & Knab
    - *excrucians* (Walker)
    - *fitchii* (Felt & Young)
    - *flavescens* (Muller)
    - *grossbecki* Dyar & Knab
    - *intrudens* Dyar
    - *leucomelas* (Meigen)[2]
    - *mitchellae* Dyar
    - *provocans* (Walker)[3]
    - *riparius* Dyar & Knab
    - *sollicitans* (Walker)
    - *spencerii* (Theobald)
    - *sticticus* (Meigen)
    - *stimulans* (Walker)
    - *taeniorhynchus* (Wiedemann)
    - *thibaulti* (Dyar & Knab)
    - *trivittatus* (Coquillett)
  - (*Protomacleaya*) *hendersoni* Cockerell
    - *triseriatus* (Say)
  - (*Stegomyia*) *aegypti* Linnaeus
- *Psorophora* (*Grabhamia*) *columbiae* (Dyar & Knab)[4]
  - (*Janthinosoma*) *ferox* (Humboldt)
    - *mathesoni* Belkin & Heinemann[5]
  - (*Psorophora*) *ciliata* (Fabricius)

Tribe CULICINI

- *Culex* (*Culex*) *pipiens* Linnaeus
  - *restuans* Theobald
  - *salinarius* Coquillett
  - (*Melanoconion*) *erraticus* (Dyar & Knab)
  - (*Neoculex*) *territans* Walker

Tribe CULISETINI

Culiseta *(Climacura)* *melanura* (Coquillett)
(Culicella) *morsitans* (Theobald)[6]
minnesotae Barr[7]
(Culiseta) *annulata* (Schrank)
impatiens (Walker)
incidens (Thompson)
inornata (Williston)

Tribe MANSONIINI

Coquillettidia (*Coquillettidia*) *perturbans* (Walker)

Tribe ORTHOPODOMYIINI

Orthopodomyia alba Walker
signifera (Coquillett)

Tribe SABETHINI

Wyeomyia (*Wyeomyia*) *smithii* (Coquillett)

Tribe URANOTAENIINI

Uranotaenia (*Uranotaenia*) *sapphirina* (Osten Sacken)

Subfamily TOXORHYNCHITINAE

Toxorhynchites (*Lynchiella*) *rutilus septentrionalis* (Dyar & Knab)

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[1] Formerly *Ae.* (*O.*) *dorsalis* (see Gutsevich et al., 1974: 201).

[2] Formerly *Ae.* (*O.*) *implicatus*, now considered a synonym for *Ae.* (*O.*) *leucomelas* (see Mezenev, 1980: 206).

[3] Resurrected from synonymy with *Ae.* (*O.*) *punctor*; *Ae.* (*O.*) *trichurus* placed in synonymy with *Ae.* (*O.*) *provocans* (see Wood, 1977: 77).

[4] Resurrected from synonymy with *Ps.* (*G.*) *confinnis* (see Belkin et al., 1970: 137).

[5] Formerly considered *Ps.* (*J.*) *varipes*, now considered to be a separate species (see Belkin and Heinemann, 1975: 363-365).

[6] Formerly considered *Cs.* (*C.*) *morsitans dyari*, *Cs. dyari* now placed in synonymy with *Cs. morsitans* (see Wood et al., 1979: 309-312).

[7] Formerly considered *Cs.* (*C.*) *silvestris minnesotae*, now returned to specific status (see Wood et al., 1979: 306, 309).

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[1] Genus in parentheses ( ) indicates genus of original description

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The New York State Flora Committee

The steering council of the New York State Flora Committee met for the first time on January 19, 1976, and established as its goals the promotion of study of the State's plant resources and the publication of this series of Museum Bulletins. These contributions will be continually updated after publication for possible incorporation into larger volumes at a later date.

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PREFACE

OUR GOAL is to present a useful and authoritative account of the plants of New York State. This series of contributions is intended to reflect the knowledge and taxonomic opinions of specialists who prepare the manuscripts, while following a generalized format for consistency. Inclusion of ecological, distributional, medical and economic information on each species is also one of our major aims. Habitat references, flowering times, pertinent synonymy, etc., apply specifically to New York plants rather than to the entire ranges. Complete illustration should facilitate identification of specimens for those who are not formally trained in botany. Descriptions are original, ordered and as complete as possible to facilitate sequential cross-referencing.

Distribution maps accompany species of seed plants, ferns, mosses, lichens and some groups of fungi. These are plotted by counties to eliminate pinpointing endangered habitats, while providing an accurate visual picture of past collecting. Maps are based on the master file at the New York State Museum, Albany, and supplemented by available data (specimens examined by the authors) from herbaria housing significant New York collections. Specific data or literature citations for any map may be obtained, on approval, from the Museum.

We hope that these bulletins will serve individuals with interest in the flora, as well as to provide information for State and Federal agencies, conservation organizations, industry and the scientific community. With these works go our hopes for the preservation and wise use of a precious and lifegiving resource . . . our State's plantlife.

Richard S. Mitchell, Editor
1978

ACKNOWLEDGMENTS

We wish to express our sincere thanks to the staffs and curators of the following institutions for their complete cooperation and hospitality when we visited to study their collections: The U.S. National Herbarium (US), The New York Botanical Gardens (NY), Cornell University (CU, BH), Environmental Science and Forestry, Syracuse (SYRF), Harvard University (GH, NEBC), Brooklyn Botanical Gardens (BKL), SUNY, Brockport, (BROC), Buffalo Academy of Sciences (BUF). Data from the above institutions were added to the master file at the New York State Museum (NYS), Albany. This file was started by Homer D. House, and has been produced and maintained in large part by Stanley J. Smith. Illustrations are originals by J. Kenneth Dean. We wish to thank the steering council of the flora committee for their review and editorial comments. We especially wish to thank Ernest O. Beal for his detailed outside review. Our thanks also to Clark Rogerson for special attention to the bibliography and Appendix I, and to Timothy McCabe for nomenclatural help with Appendix II.

IMPORTANT NOTE

All economic uses, folklore, medical and pharmaceutical notes, uses as foodstuffs, etc., are compiled from the literature and do not represent an endorsement by the authors or the New York State Museum. Some of the uses may, indeed, be dangerous if incorrectly employed. Some are not effective and are presented for historical interest only.

Contributions to a Flora of New York State
Polygonaceae (Buckwheat Family)

The Polygonaceae: a cosmopolitan family of flowering plants including herbs, shrubs, vines and some trees; most members in boreal North America are annual or perennial herbs. Three genera, *Polygonum, Rumex* and *Polygonella,* are native to New York State. Buckwheat *(Fagopyrum)* and Rhubarb *(Rheum)* escape cultivation and may persist on disturbed sites. The seed-like fruits (achenes) are well-known wildlife foods, sown for waterfowl. Buckwheat is grown for human consumption as well as for livestock. Leaves of some Docks *(Rumex)* are boiled for pot-greens and medicine, and the cooked petioles of Rhubarb are used in stews and pies. Oily exudates of some *Polygonum* species are peppery and may cause eye irritation, hence such names as Water Pepper and Smartweed. Buckwheat and some species of Smartweed have been reported as bee plants which yield a pleasant honey.

Most members of the family are sun-loving, and their habitats range from disturbed ground to truly aquatic situations. A few are noxious weeds of cultivated fields and gardens.

FAMILY DESCRIPTION

Our native genera are characterized by sheathing, oblique or cylindric-tubular stipules (ocreae) which arise from more or less swollen, often multilacunar nodes. Sheathing stipules may shatter early or be persistent. Leaves are alternate and simple. Flowers are borne from within sheathing bracts (ocreolae) singly, in fascicles or in whorls. These are usually arranged in racemes or panicles which may be scattered or clustered into spike-like inflorescences. The perianth is of sepals only, but is usually petaloid, ranging in color from white to deep red-purple, yellow or greenish. Lobes of the perianth are 4–6, in a single series, or two whorls of three. Flowers may be bisexual (sometimes heterostyled) or unisexual, plants being monoecious, dioecious or polygamous. The single ovary has one basal ovule, and bears two or three styles. Stamens are 4–12 in number, sometimes associated with a glandular disc. Extrafloral nectaries are also known. The simple fruits are hard achenes, enclosed in the persistent perianth or exserted. Plants are perennial from stolons or rhizomes, biennial or annual from a taproot or fibrous root system.

KEY TO GENERA

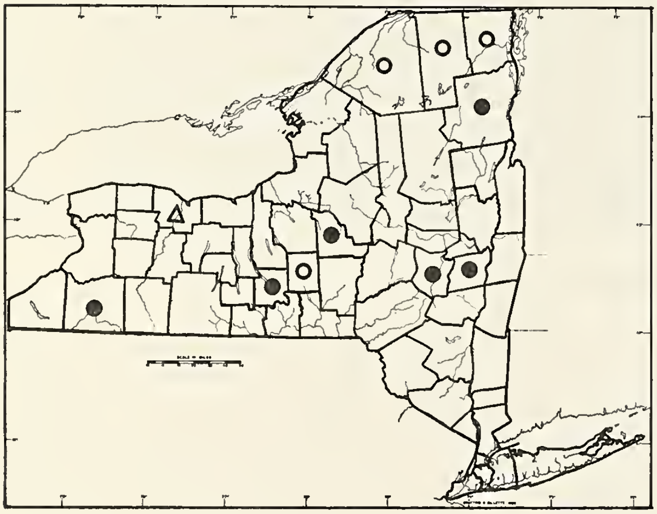
1. Basal leaves very large, 15–40 cm. in length and width, from broad, fleshy petioles; achenes winged .... 1. *Rheum* (p. 2)
1. Basal leaves not so broad or robust; petioles not conspicuously fleshy; achenes not winged .... (2)
    2. Flowers 1 per bract, reflexed, in elongate terminal racemes; leaves linear, stiff, soon dropping .... 5. *Polygonella* (p. 60)
    2. Flowers 2-more per bract, usually in whorls or fascicles which are scattered or densely compacted into inflorescences; leaves persistent, variously shaped .... (3)
3. Perianth lobes 6, in 2 whorls; fruit usually enclosed in a persistent perianth of wing-like valves, kernel-like tubercles or both .... 2. *Rumex* (p. 3)
3. Perianth lobes 4–5; fruit enclosed in, or exserted from, an unspecialized or laterally winged perianth .... (4)
    4. Achene strongly exserted from the perianth, 5–7 mm. long .... (5)
    4. Achene enclosed or weakly exserted from the perianth, usually less than 5 mm. in length .... 3. *Polygonum* (p. 20)
5. Leaves cordate-deltoid; flowers in panicles .... 4. *Fagopyrum* (p. 58)
5. Leaves not cordate-deltoid; flowers in fascicles in the leaf axils .... 3. *Polygonum* (p. 20)

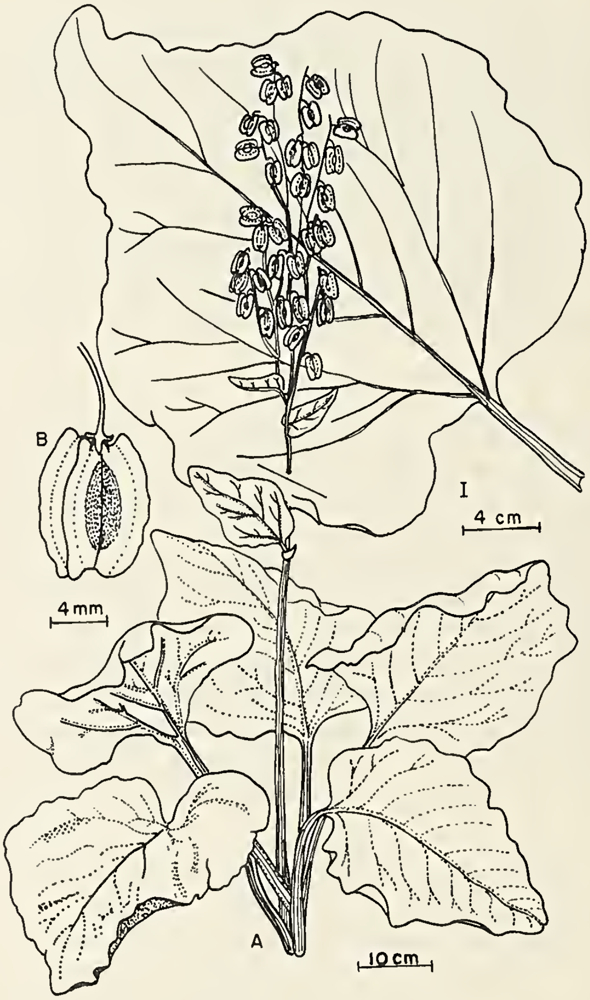
1. RHEUM

Common Name: Rhubarb

A primarily Asiatic genus. Two species are widely cultivated in New York State. Of these, the Common or English Rhubarb escapes cultivation in sufficient numbers to be listed here.

Description: Flowers bisexual; **stigmas** 3, dilated and fimbriate-tufted; **styles** deflexed, short; **ovary** 3-angled, unilocular with a single orthotropous **ovule; placentation** basal; **fruit** a large, triquetrous achene with undulate wings; **seed** conforming to the achene walls; **embryo** exterior to the mealy endosperm; **stamens** usually 9; **perianth** of 6 lobes, the outer slightly larger; perianth remaining small, not accrescent or enclosing the achene; **pedicels** jointed; **inflorescence** a large, elongate panicle (in ours); **basal leaves** very large and broad; leaves much reduced upward toward the inflorescence; **basal petioles** fleshy; **stems** stout, hollow and tall; **root** fleshy, pink, perennial.





1. *Rheum rhaponticum* L.

Common Names: Rhubarb, English Rhubarb
Type Description: Linnaeus, Species Pl., p. 371, 1753
Origin: Siberia (spread through cultivation)
Habitats: Waste places and old fields
Habit: Stout perennial herb
Flowering: Late May-August
General Distribution: Northern United States and Canada as an escape from cultivation (Eurasia)

Description: Flowers bisexual; **stigmas** 3, tufted and reflexed; **styles** 3; **ovary** 3-angled, becoming a strongly 3-winged **achene,** 8–10 mm. in length, dark brown with paler wings, not enclosed in the small perianth; **stamens** (6–8) 9; **perianth** of 6 lobes, greenish to white or pink; **inflorescence** a terminal panicle of fascicles and racemes, up to 30 cm. in length, ribbed, glabrous stalks up to 2 m. in height; **leaves** entire, crinkled, cordate-ovate to deltoid; **basal leaves** 20–40 cm. in diameter, palmately veined; **petioles** stout, ribbed, especially the lower ones; **nodes and internodes** stout, hollow; stems and petioles often striped with red and a blush of rose color; **roots** large, fleshy, pinkish (2n = 44).

Infraspecific Variability: Petioles may vary in fleshiness and color in the escapes; Bailey (1949) stated that the species name is used tentatively due to the possibility that cultivated Rhubarb represents a series of variants of possible hybrid origin.

Importance: Rhubarb is grown for its fleshy, edible petioles, which produce a tart sauce when boiled; the stewed petioles are usually sweetened and used in pies—frequently with strawberries or flavoring added; they are also used to flavor wine; due to high oxalic acid content of all parts, they should be cooked well to avoid urinary irritation; flowers have also been cooked; deaths reported from eating the greens are probably not from oxalate crystals, but from glycosides. Rhubarb has been known in cultivation in Europe since the 1760's, but did not become popular there or in America until mid-19th century. The roots contain rhapontin, and have been powdered for use as a laxative and for stomach pains.

2. RUMEX

Common Names: Dock, Sorrel

A circumboreal, almost cosmopolitan genus of herbs which occur in sunny sites, often disturbed ground and wet places. Some are spreading, noxious weeds. There are about 15 native and introduced species of *Rumex* in New York State. Hybrids appear to be more common than formerly reported, and these sometimes confuse the identifier.

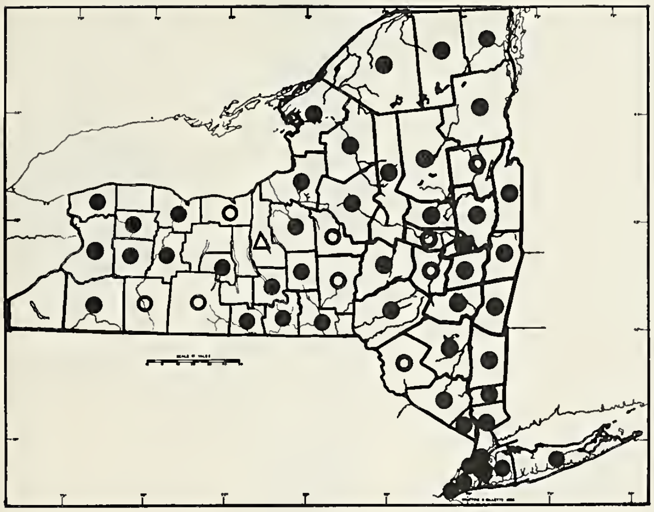
Description: Flowers bisexual or unisexual; plants with only perfect flowers or monoecious, dioecious or polygamous; **stigmas** 3, tufted, stellate-fimbriate; **styles** 3, often short and deflexed; **ovary** 3-angled, unilocular, with a single, orthotropous **ovule** adjacent to one wall; **placentation** basal; **fruit** a 3-angled achene enclosed with an accrescent inner perianth; **achene** pyramidal with shiny yellow-brown to red-brown or black surfaces; **seed** conforming within the achene walls; **embryo** nearly straight, lying along the flat surface of one achene wall, outside the mealy **endosperm; stamens** 6, in pairs opposite the outer perianth lobes: **filaments**, short, anther sacs basifixed, yellow to red or purple, nearly equaling the perianth at anthesis; **perianth** parts 6, green to reddish, in two whorls of 3, slightly united into a connate base; **outer lobes** linear to lanceolate, not enlarging in fruit, often becoming reflexed; **inner perianth parts** usually enlarging in fruit to become veiny valves, which enclose the fruit (fusing to it in one variety); **valves** entire to toothed or spined, with reticulate venation, variously shaped from oblong to triangular or cordate, much enlarged in some species; **fruiting perianth** greenish to yellow, red or usually browning with age; midvein of one or more valves developing callosities called **tubercles** ("grains") which may be smooth or variously pitted (some species are without tubercles); **pedicels** often jointed, becoming deflexed or flattened in some; **inflorescence** a terminal or axillary series of panicles, composed of fascicles of 3-many flowers; fascicles subtended by sheathing, usually scarious **bracts; leaves** simple, entire to crenulate, undulate or strongly crisped; **basal leaves** petiolate, often forming rosettes; **leaves and petioles** much reduced upward into the inflorescence where they are often called "bracts"; **stipules** tubular, hyaline and sheathing, but usually shattering early; **nodes** usually scarcely swollen; **internodes** glabrous, greenish to red, smooth or fluted; **stems** simple or branched, erect or ascending from an annual, biennial or perennial **taproot** system (rarely with runners).

KEY TO SPECIES OF RUMEX

NOTE: *Rumex* specimens should be collected with mature fruit (and runners, if present) or they are difficult to identify. Immature specimens should be compared with those in a good herbarium.

1. Plants dioecious (rarely polygamous); leaves hastate, sagittate or sometimes unlobed ....(2)
1. Plants monoecious or with bisexual flowers; leaves not sagittate or hastate ....(4)
    2. Perianth small, enclosing the fruit, not expanded into veiny valves .... 1. *Rumex acetosella* (p. 5)
    2. Perianth expanded beyond the fruit into veiny valves ....(3)
3. Leaves mostly cauline, broadly sagittate midvein of some valves with tubercles when mature .... 2. *Rumex acetosa* (p. 6)
3. Leaves more basal, narrowly hastate or unlobed; midvein of valves without tubercles .... 3. *Rumex hastatulus* (p. 7)
    4. Perianth small in fruit, barely as broad as the achene .... 4. *Rumex conglomeratus* (p. 8)
    4. Perianth or its spines expanded into valves extending well beyond the achene ....(5)

5. Valve margins entire or irregular-denticulate but not toothed or spined ....(9)
5. Valve margins with teeth or spines ....(6)
    6. Mature valves shallowly toothed, teeth not spine-tipped ....13. *Rumex crispus X obtusifolius* (p. 17)
    6. Mature valves with sharply pointed teeth or spines ....(7)
7. Well-developed tubercules 3; fruiting perianth with slender spines ....5. *Rumex maritimus* (p. 9)
7. Well-developed tubercle 1; fruiting perianth with sharp teeth..........(8)
    8. Leaves of the basal cluster conspicuously larger than the cauline leaves, frequently fiddle-shaped; pedicel jointed toward the middle; flower clusters not contiguous ....6. *Rumex pulcher* (p. 10)
    8. Leaves not fiddle-shaped; cauline leaves mostly broad, cordate-ovate; pedicels jointed obscurely near the base; flower clusters frequently contiguous ....7. *Rumex obtusifolius* (p. 11)
9. Stems with little or no lateral branching; leaves usually dark green to reddish ....(13)
9. Stems with well-developed lateral branching; leaves with a pale sheen..........(10)
    10. Fruiting pedicels strongly deflexed from their immediate bases, mostly uncurved, 2–5 times the length of the valves..........8. *Rumex verticillatus* (p. 12)
    10. Fruiting pedicels mostly curved, only one half to twice as long as the valves ....(11)
11. Tubercles broad, conspicuous, over half the width of the valves ....9. *Rumex pallidus* (p. 13)
11. Tubercles narrower, much less than half the width of the valves..........(12)
    12. Valves deltoid in outline; tubercles consistently 3 in number..........10. *Rumex triangulivalvis* (p. 14)
    12. Valves ovate-obtuse; tubercles developing inconsistently from 1–2 (3) per fruiting perianth ....11. *Rumex altissimus* (p. 15)
13. Mature valves broader than long, kidney-shaped; tubercles undeveloped ....12. *Rumex longifolius* (p. 16)
13. Mature valves as long as, or longer than broad, cordate, obtusely pointed at tips ....(14)
    14. Well-developed tubercles 1 or 2 ....(16)
    14. Well-developed tubercles on all three valves ....(15)
15. Pedicels jointed near the middle; leaves crisped and convoluted at the margins (weedy) ....13. *Rumex crispus* (p. 17)
15. Pedicels jointed below the middle; leaves not strongly crisped or convoluted (aquatic habitats) ....14. *Rumex orbiculatus* (p. 18)
    16. Tubercle about half the length of the valve; valves 4–5 mm. long at maturity.....13. *Rumex crispus* (p. 17)
    16. Tubercle less than half the valve length; valves 6–9 mm. long..........(17)
17. Leaves pale green, margins flat, undulating or slightly crisped; mature valves about 8 m. long ....15. *Rumex patientia* (p. 19)
17. Leaves dark, shiny green, margins crisped and convoluted; mature valves 5–6 mm. in length ....13. *Rumex crispus* X *patientia* (p. 17)



1. ***Rumex acetosella*** **L.**

Common Names: Sheep Sorrel, Red Sorrel, Sour Grass

Type Description: Linnaeus, Species Pl., p. 338, 1753

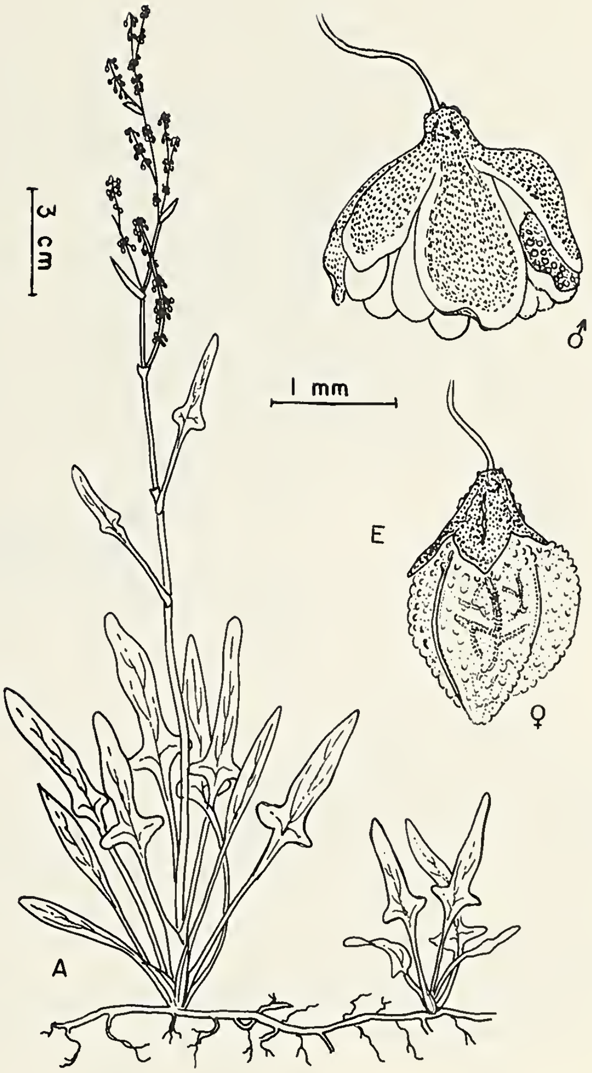
Origin: Eurasia

Habitats: Acid soil, fields, lawns and waste places

Habit: Erect to spreading perennial or occasionally annual

Flowering: April–September

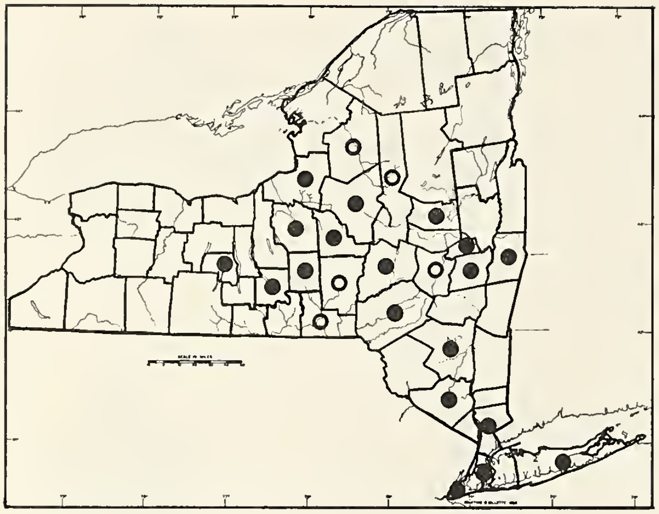
General Distribution: Ubiquitous weed of boreal climates

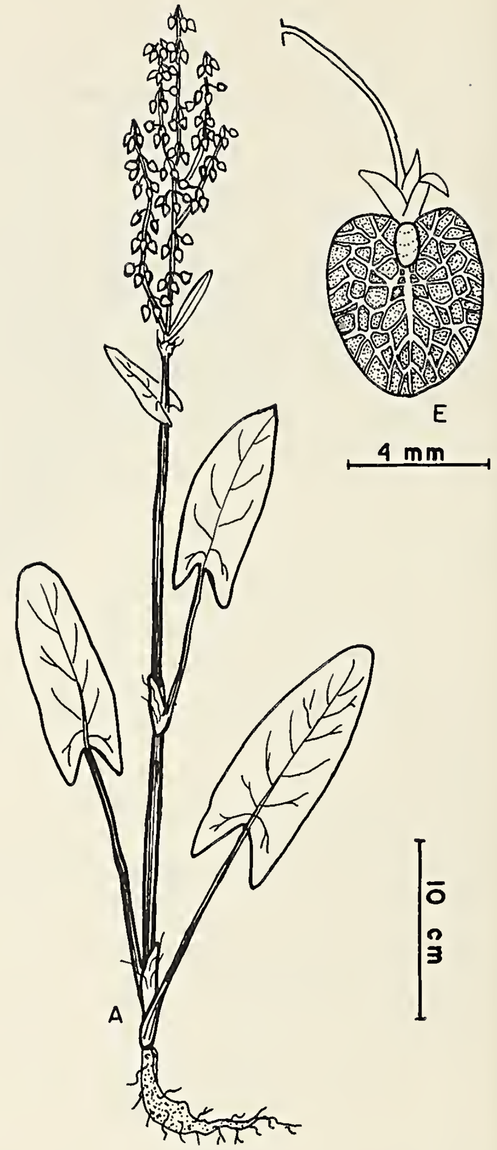


Description: Plants dioecious, rarely polygamous; **stigmas** 3, fimbriate, almost sessile on 3 short **styles**; **ovary** 1, becoming a weakly 3-angled achene; **achene** 1–1.5 mm. long, almost as broad, yellowish to reddish-brown; stamens 6: filaments short, anther sacs yellowish to red-tinged, equaling or slightly exceeding the perianth; **inner perianth lobes** of male flowers obovate, of females broadly ovate; **female perianth** about equaling the achene in fruit, not expanded into valves, and lacking tubercles or distinct innervation; **outer sepals** in both sexes lanceolate, reddish; **bracts** sheathing, usually red with hyaline, often lacerate tip; **inflorescence** a slender, much-branched panicle of small fascicles; **flowers** nodding on **pedicels** which are up to twice as long as the perianth; leaves mostly basal, usually hastate, but some lacking lobes, obovate to narrowly lanceolate, 3–8 cm. long, with narrowly attenuated basal lobes which are divergent (often upward); **petioles** of lower leaves often longer than the blades; **stipules** reddish or brownish, shattering, with lacerate, hyaline extremities; **nodes** slightly swollen, reddish; **internodes** ribbed, slender, glabrous; stems usually unbranched below the inflorescence, 20–40 cm. tall; plants usually arising from running **rhizomes** which are slender and can be several feet long (2n = 14, 28, 42).

Infraspecific Variation: A number of cytotypes and varieties have been described for this species. Our New York material seems to be mostly of the group described as ssp. *angiocarpus* (Murb.) Murb., in which the inner perianth becomes adnate to the achene. Hastate lobes are frequently missing from the leaves, even at the base.

Importance: The fresh, chopped herb has been used medicinally as a diuretic, refrigerant and diaphoretic; the juice has been used in kidney and urinary disorders; its sour taste derives partly from oxalate, however, so appropriate cautionary measures should be taken.



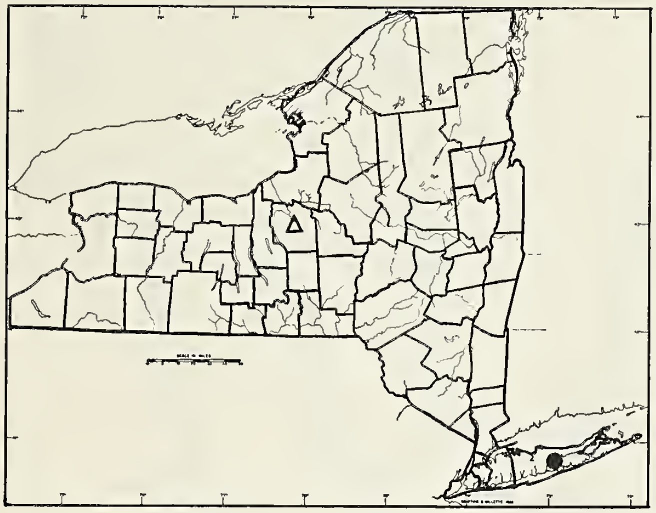


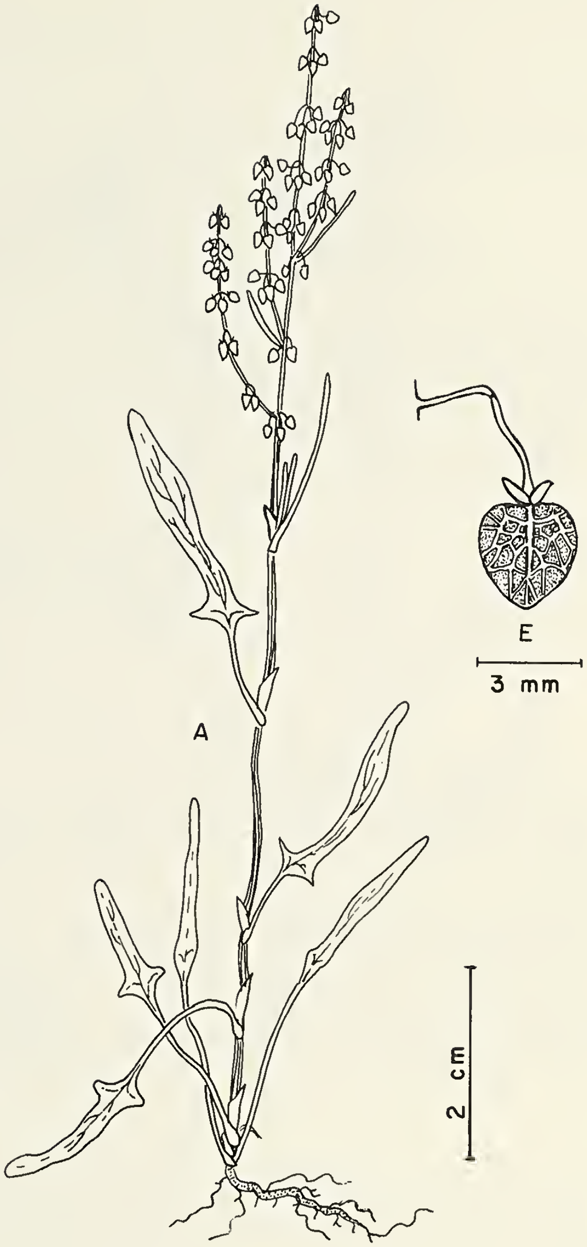
2. *Rumex acetosa* L.

Common Names: Garden Sorrel, Green Sorrel
Origin: Europe, probably England
Type Description: Linnaeus, Species Pl., p. 337, 1753
Habitats: Waste places, fields, lawns and gardens (cultivated rarely)
Habit: Coarse, erect perennial
Flowering: May–September
General Distribution: Circumboreal adventive, in the United States south to Pennsylvania

Description: Plants dioecious; **stigmas** 3, fimbriate-branched from a flared base; **styles** 3, membranous, arched downward over the **ovary** apex; ovary 1, becoming a three-angled **achene**; achene dark reddish-brown with paler, acute angles, 2–2.5 mm. long, enclosed by the valves; **inner perianth lobes** ovate, becoming **valves** 4–6 mm. in length, veiny; only one valve usually developing a **tubercle** at maturity; **outer sepals** triangular-ovate, reflexed even before fruiting, about 1.5 mm. long; **stamens** 6: filaments short, anther sacs about equal to the perianth; **bracts** usually reduced, truncate, eciliate, sheathing; **inflorescence** a branched panicle of many distant to approximate, whorled fascicles; **pedicels** about equal in length to perianth in fruit; **cauline leaves** sagittate oblong to broadly lanceolate; **lower leaves** petioled, the upper ones almost sessile; **basal leaves** (when present) with deeply cordate to clasping bases, or sagittate with petioles; **stipules** scarious, disintegrating to fibers; **nodes** scarcely swollen, papillose or strigose; **internodes** stout, ribbed, stem 30–90 cm. tall, usually arising singly from a stout perennial **root** (2n = 12 + XX, female; 2n = 12 + XYY, male; tetraploids also reported).

Importance: Once used more frequently in cooking, especially as a salad green or soup flavoring to lend a sour taste. Said to disagree with gouty persons due to acidity from oxalic acid. Reputed to lessen the appetite, aid indigestion and lessen fevers (folklore). Chopped leaves mixed with vinegar and sugar make green-sauce added to meat dishes. A decoction from the root gives a rich wine color to barley soup or makes a false wine for sick persons. Medicinally, it has been used for its astringent properties in mixtures for the treatment of cutaneous tumors and scrofulous deposits. It has also been used for ringworm, scurvy and as a gargle for sore throats.





3. *Rumex hastatulus* Baldw. ex Ell.

Common Names: Heart Sorrel, Wild Sorrel

Type Description: Baldwin in Elliott, Sketch. Bot. S.C. and Ga., p. 416, 1817

Synonym: *R. engelmannii* Meisn. (sometimes misspelled "hastulatus")

Origin: Native of Eastern United States

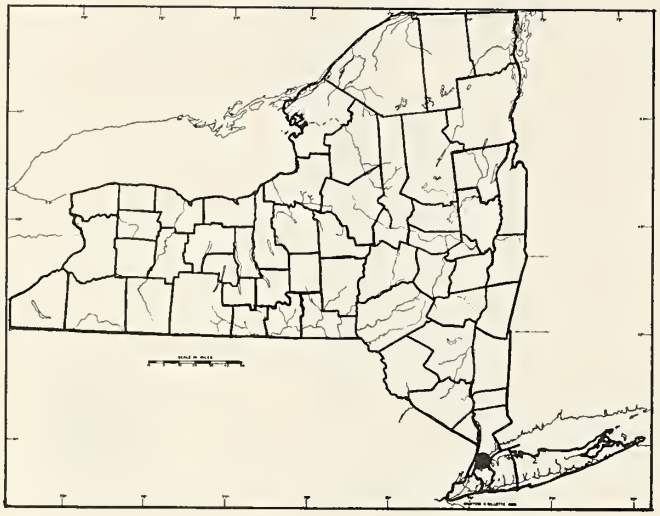
Habitats: Sandy to lateritic soils, open places and disturbed sites

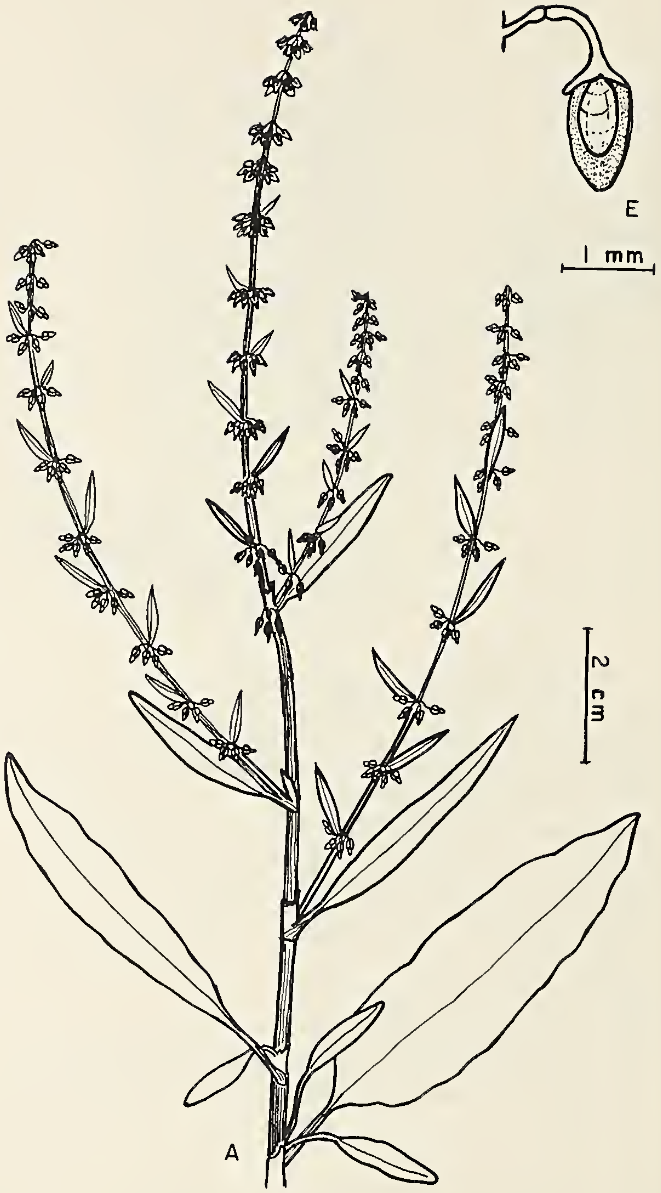
Habit: Slender perennial

Flowering: May–August

General Distribution: Mostly in the Coastal Zone, Massachusetts to Texas and the Lower Mississippi Valley

Description: Plants dioecious; stigmas 3, stellate-fimbriate, **styles** 3, deflexed; single **ovary** 3-angled becoming a strongly 3-angled **achene**; achene yellowish-brown, translucent, with a distinct dark line at each angle, 0.9–1.2 (1.5) mm. long, 0.6–0.7 mm. wide, enclosed in fruit by the expanded **valves**; valves 2.5–3.5 mm. long in fruit, pale pinkish to yellow or suffused with purple, central nerve strong but not forming **tubercles**; outer **sepals** reflexed, about 1 mm. long; **stamens** 6: filaments short, anther sacs not equaling perianth in length, yellowish to reddish; **inflorescence** 10–30 cm. long, a narrow, slender panicle of fascicles; **bracts** reduced, scarious, hyaline to brownish; **pedicels** about the length of the perianth; **leaves** glabrous, smooth variable in shape, but lower ones usually with hastate lobes; **cauline leaves** short-petioled to sessile, usually unlobed or only slightly hastate; **basal leaves** 2–10 cm. long, terminal lobe lanceolate, acute to obtusely tipped, petioled; **nodes** slightly swollen; **internodes** elongate above basal cluster; **stem** usually unbranched from a slender, perennial **rootstock** which may simulate an annual **taproot** ($2n = 12 + XX$, female; $2n = 12 + XYY$ male).





4. ***Rumex conglomeratus*** **Murray**

Common Names: Green Dock, Clustered Dock

Type Description: Murray, Prod. Fl. Grott., p. 52, 1770

Origin: Europe

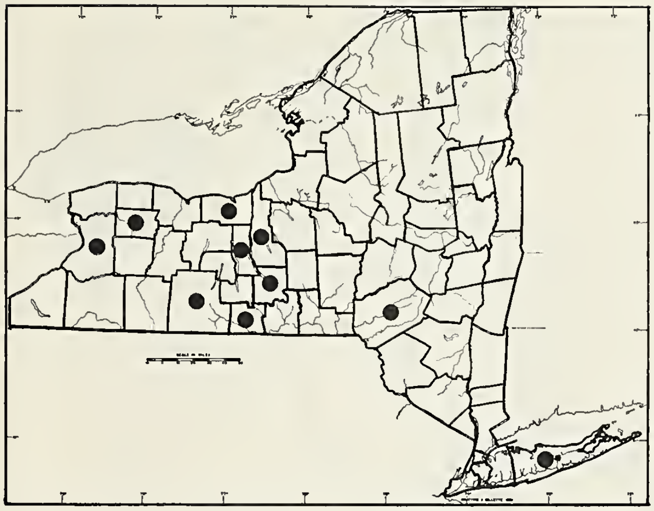
Habitats: Waste places, open shores, roadsides

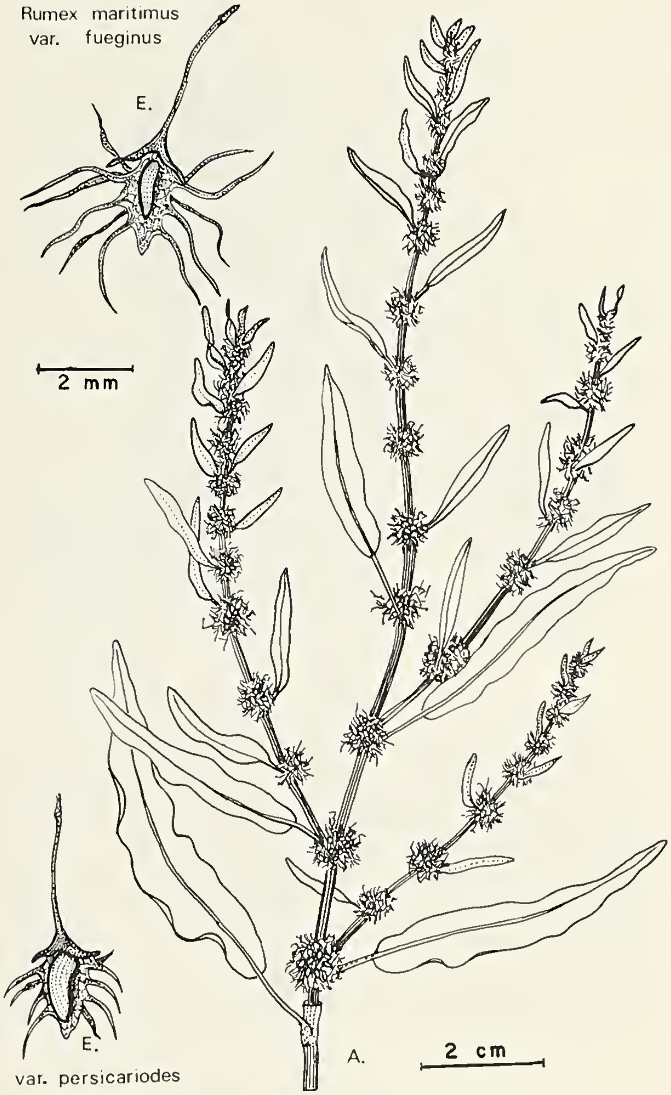
Habit: Coarse, perennial

Flowering: June–August

General Distribution: European and naturalized in extra-tropical New World

Description: Flowers bisexual (strongly protandrous); **stigmas** 3, stellate-fimbriate; **styles** 3, deflexed; **ovary** 1, becoming a 3-angled **achene** about 1.8 mm. long and 1.4 mm. wide; **achene** glossy, dark reddish-brown, with obtuse angles and a broad base; **valves** oblong to oblong-ovate, 2–3 mm. long, 1–1.5 mm. wide, barely exceeding or not exceeding the achene width; each valve with a **tubercle** which is plump and covers most of the valve width; **outer perianth** lobes appressed, ascending 1–1.5 mm. in length; **stamens** 6: filaments short, anther sacs yellowish, not exceeding the perianth; **inflorescence** a panicle of divergent or loosely ascending racemes of fascicles, subtended by leafy "**bracts**" for at least half its length; **pedicels** short, stout, (1–2 mm.) equaling or shorter than the fruiting perianth; **lower leaves** oblong to oblong-lanceolate, 6–20 cm. long, with truncate to cordate bases; leaves not crisped; **upper leaves** narrower and shorter with cuneate bases; **stems,** 0.6–1 (1.5) m. tall, one to several from a stout, branched **rootstock** (2n = 20).



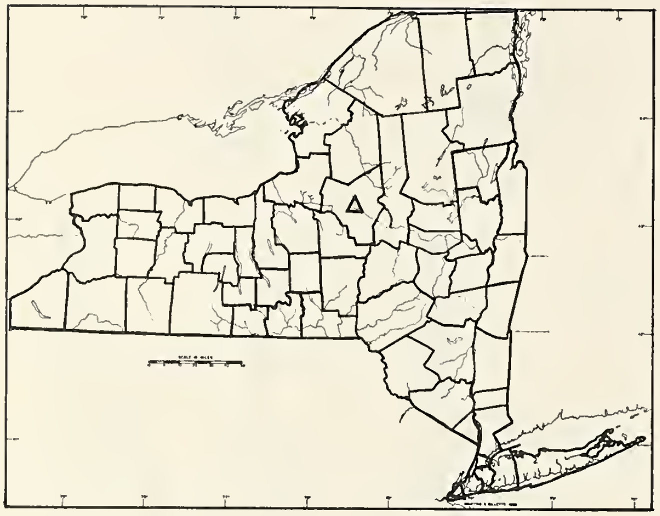


5. ***Rumex maritimus* L.**

Common Name: Golden Dock
Type Description: Linnaeus, Species Pl., p. 335, 1753
Synonyms: *R. persicarioides* L. *sensu* many American authors, *R. fueginus* Phil.
Origin: Uncertain
Habitats: Shorelines, strands, disturbed sites
Habit: Erect to sprawling annual or biennial
Flowering: July–September (New York)
General Distribution: East to west coasts of Canada and the United States, South America, Eurasia

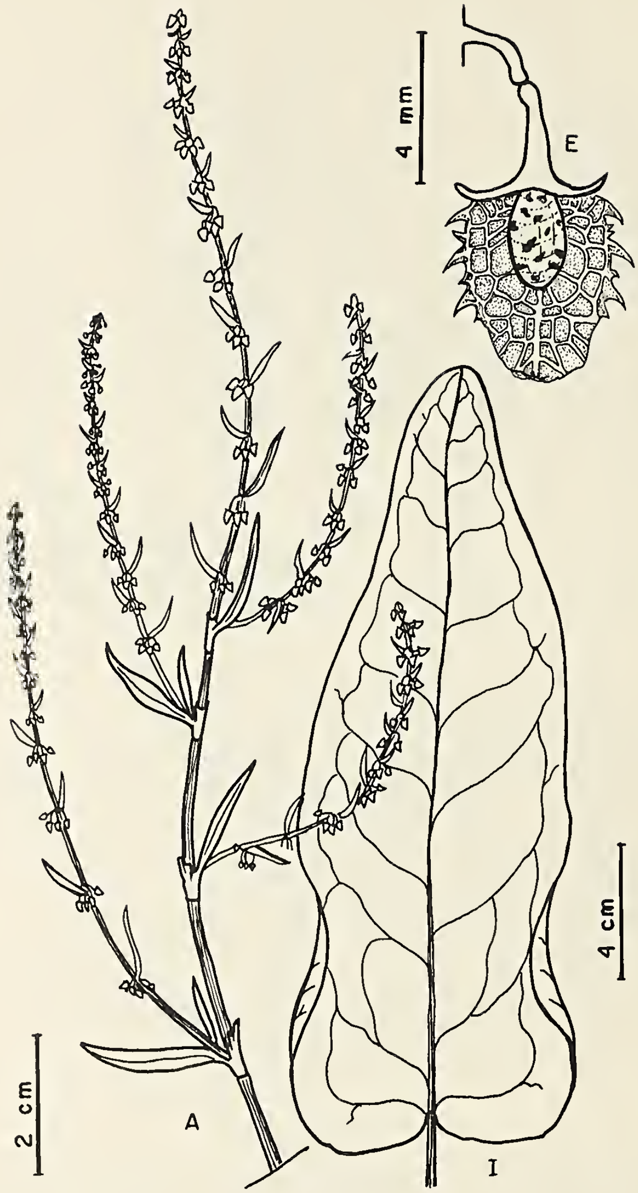
Description: Plants with bisexual flowers, protandrous, stigmas 3, stellate-fimbriate with 3 deflexed **styles; ovary** 1, becoming a 3-angled **achene;** achene golden-brown or pale, elliptic in outline, 1–1.4 mm. long, with sharp angles, enclosed by the perianth in fruit; **stamens** 6: filaments short, anther sacs yellowish, not exceeding the perianth; **valves** greenish to golden or red-brown, reticulated, papery 2–2.5 mm. long; each **valve** with 4 to 6 spiny **teeth,** diverging 0.5–2.5 mm. beyond the fruit; all valves with prominent, paler **tubercles** which are lanceolate to plump-ellipsoid; **outer sepals** linear-lanceolate, ca. 1 mm. in length, somewhat recurved; **pedicels** slender, articulated near base and deflexed, 1–2 times perianth length; **inflorescences** of dense, globose clusters of fascicles, in the axils of leaves, appearing terminal in dwarf plants, becoming reddish-brown or golden in fruit, leafy braceate; **leaves** linear-lanceolate with acute to obtuse tips and usually truncated bases (may be slightly crisped or papillate) **upper leaves** lanceolate to elliptic, short petioled, similar to leafy bracts, linear in the upper inflorescence; **petioles** up to 4 cm. long on basal leaves; **stipules** scarious, disintegrating; **stems** hollow, erect to much-branched and sprawling; **nodes** scarcely swollen; **plants** 3–60 cm. tall from a fibrous **root** (2n = 40).

Note: This species is a member of the highly variable species complex called the Maritimi, which presents some perplexing nomenclatural problems. The only apparently consistent character separating *R. persicarioides* from *R. maritimus* is plumpness of the tubercles. To recognize these taxa as infraspecific to a single species requires subordination of one of these two Linnaean binomials, so this will be considered in a separate publication. Plants corresponding morphologically with *R. persicarioides* are found in New York on Long Island. The remainder of our materials are *R. maritimus* L. var. *fueginus* (Phil.) Dusen.

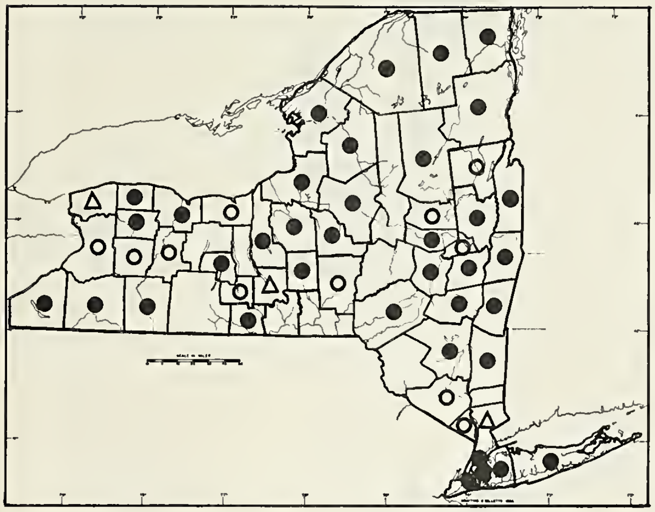


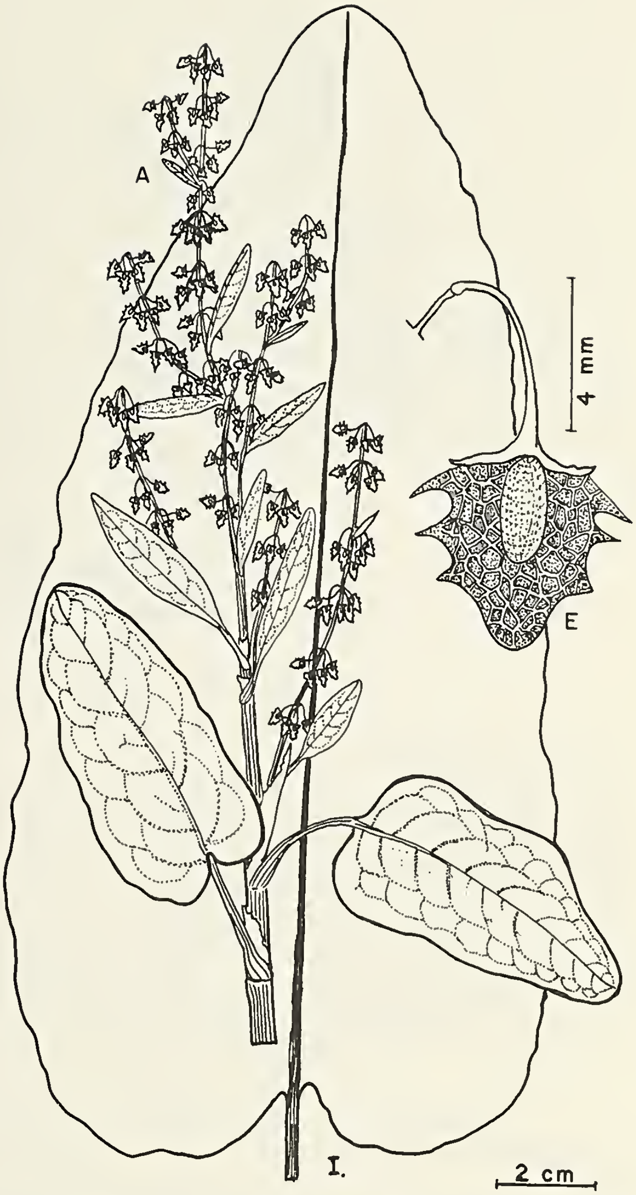
6. *Rumex pulcher* L.

Common Name: Fiddle Dock
Type Description: Linnaeus, Species Pl., p. 336, 1753
Origin: Mediterranean Basin
Habitats: Waste places and roadsides
Habit: Tall, slender perennial with a large inflorescence
Flowering: May–July
General Distribution: Weedy on major continents



Description: Plants with bisexual, protandrous flowers; **stigmas** 3, stellate-fimbriate; **styles** 3, deflexed; **ovary** 1, becoming a 3-angled **achene**; achene dark reddish-brown, glossy, deltoid in outline, base broad, not stipitate, angles somewhat obtuse, 3–4 mm. long enclosed in fruit by the valves; **stamens** 6: filaments short, anther sacs yellowish, not exceeding the perianth; **valves** ovate-triangular, 4.5–6 mm. long, 2.5–4.5 mm. wide in fruit, strongly reticulated with 2–5 teeth per valve margin; all valves usually bearing **tubercles;** tubercles may be unequal in size at maturity, with coarse, warty surfaces; **outer perianth** parts 2–3 mm. long, ascending; **inflorescence** accounting for up to ¾ of the plant height with fascicle-clusters often forming tangled racemes; fascicles remote, not contiguous; **pedicels** thick, very short to almost the length of the perianth, articulated near the middle; **lower leaves** often fiddle-shaped, somewhat crisped, long petioled, 3–15 cm. in length, sometimes with a pubescence; **upper leaves** much reduced; **stipules** brownish, lacerate, but often persistent; **nodes** somewhat swollen; **stems simple** or branched at the base, ribbed, arising from a stout, perennial root; **plants** 40–85 cm. tall (2n = 20).



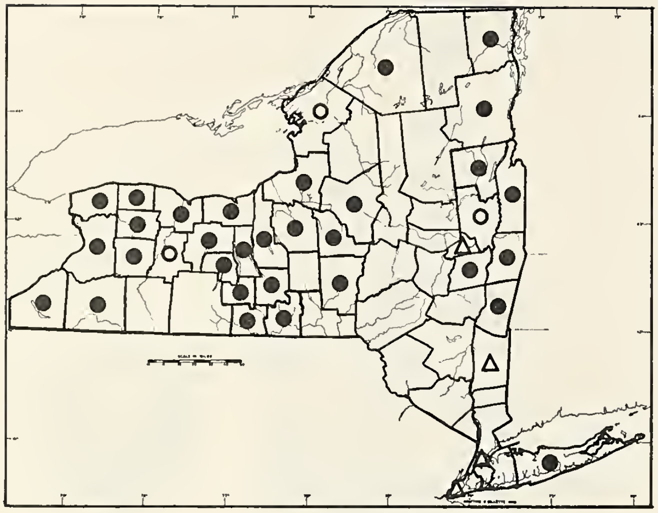


7. *Rumex obtusifolius* L.

Common Names: Bitter Dock, Red-veined Dock, Blunt-leafed Dock, Butter Dock
Type Description: Linnaeus, Species Pl., p. 335, 1753
Synonym: *Rumex crispatulus* Michx.
Origin: European
Habitats: Waste places, roadsides, pastures
Habit: Coarse, tall, erect perennial
Flowering: June–August
General Distribution: A more or less cosmopolitan weed

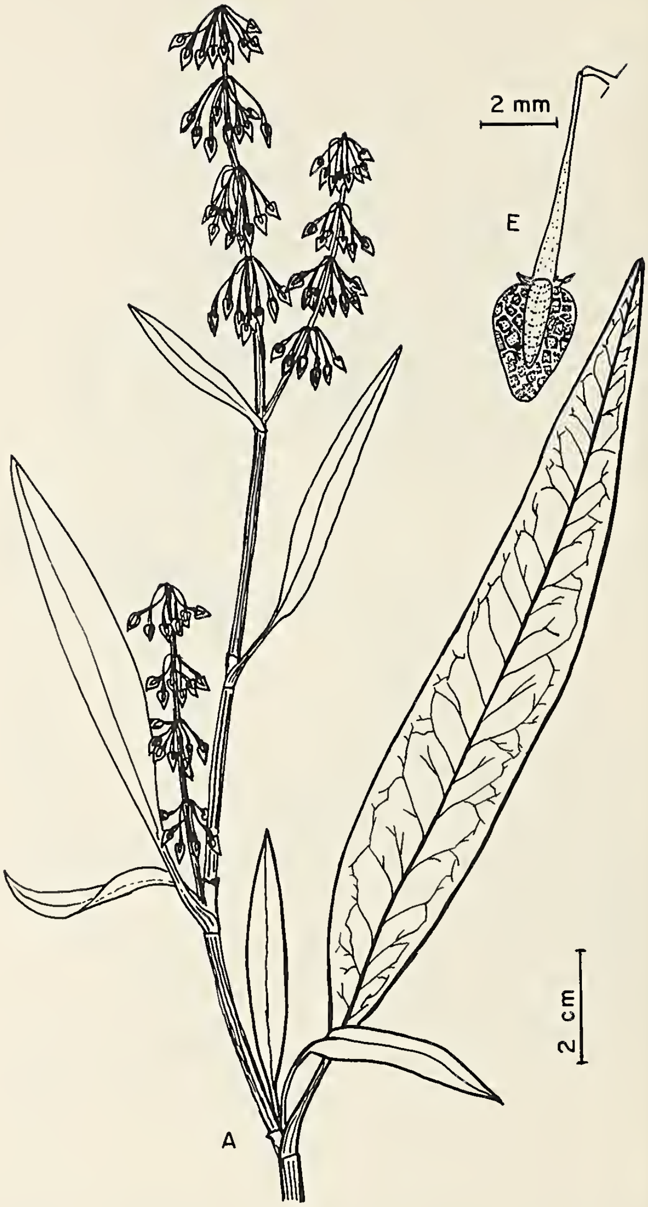
Description: Plants with bisexual, protandrous flowers; **stigmas** 3, stellate-fimbriate; **styles** 3, deflexed; **ovary** 1, becoming a 3-angled **achene;** achene golden to mahogany or chocolate-brown, lustrous, uniformly colored, elliptic, 2.2–5 mm. long, not sharply angled; **stamens** 6: filaments short, anther sacs yellowish, shorter than the perianth parts; **valves** triangular-ovate, 4–6 mm. long in fruit, reticulately veined, each margin with 2–4 subulate teeth; one valve (2–3) with a prominent **tubercle** which is plump and finely reticulated; **outer sepals** oblong, narrow, 1.5–2 mm. long, usually not reflexed; **upper inflorescence** with scarious **bracts; lower inflorescence** with leafy bracts and some small, lanceolate leaves; **inflorescence** an elongate panicle of upright or divergent racemes of fascicled, slender-pediceled flowers; **fascicles** remote below and more contiguous above; **pedicels** about 2–3 times the length of the fruiting perianth, jointed in the lower third, often near the base; **lower leaves** red-veined, long petioled, membranous and not crisped, 10–35 cm. long, 5–15 cm. wide, narrowly to broadly ovate, subcordate, apex rounded or blunt; **lower leaf** surfaces papillate with minutely puberulent veins; leaf margins crenulate; **upper leaves** oblong to lanceolate with acute apices and rounded bases; **nodes** slightly swollen; **stipules** brownish, often lacerate but persistent; **stem** stout ribbed, usually simple below the inflorescence, about 60–150 cm. tall, arising from a stout, perennial **root** ($2n = 50$).

Importance: This species has been used in the past in decoctions for scurvy and circulatory problems, outwardly applied as an astringent and to cure itching from nettle burns; it is a farm weed which harbors the Turnip Fly.



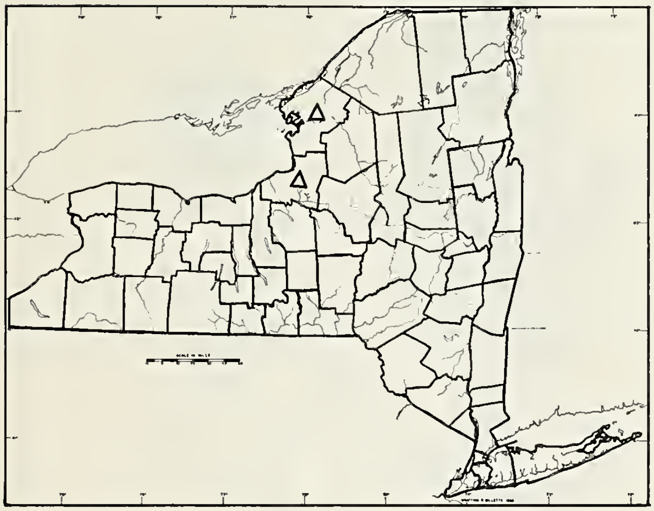
8. *Rumex verticillatus* L.

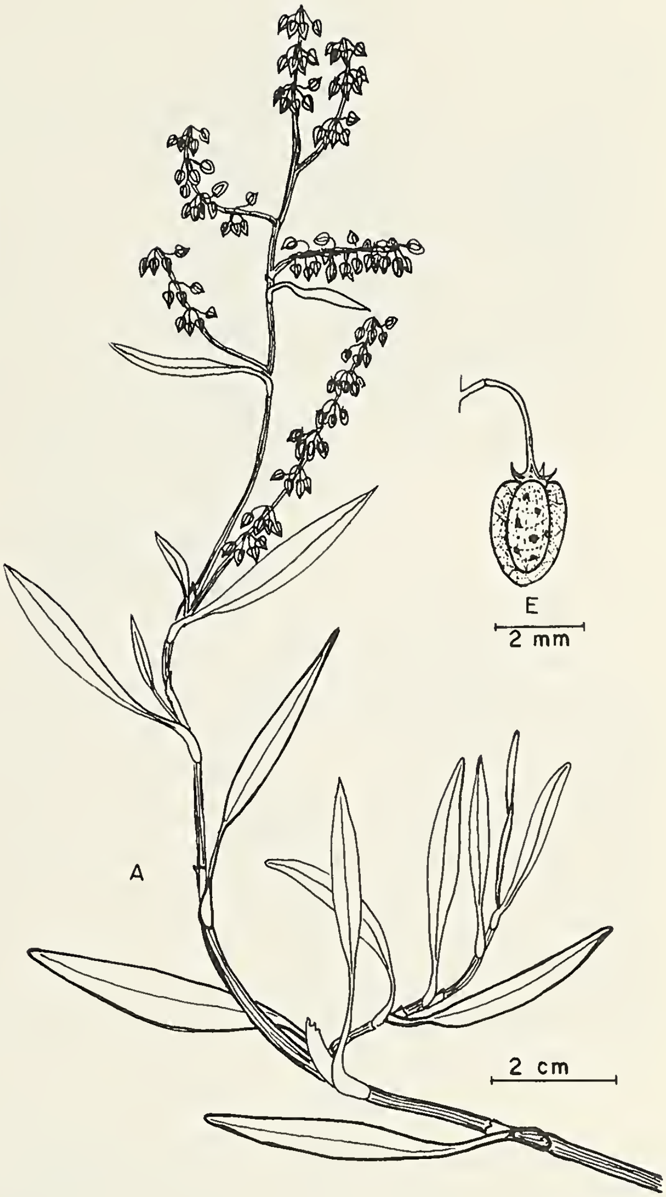
Common Names: Swamp Dock, Water Dock
Type Description: Linnaeus, Species Pl., p. 334, 1753
Origin: Eastern United States
Habitats: Wetlands, lakes, streamsides
Habit: Erect, sparsely branched perennial
Flowering: June–September
General Distribution: Eastern and Central United States and Eastern Canada



Description: Plants monoecious (androgynous); **stigmas** 3, stellate-fimbriate; **styles** 3, deflexed; **ovary** 1, becoming a 03-angled, brown **achene**; achene 2.8–3.1 mm. long, strongly stipitate, the angles dark, lined with hyaline margins; **stamens** 6: filaments short, anther sacs reddish, equaling the perianth; **valves** 3.5–5 mm. long in fruit, triangular-ovate, elongated near the apex, often heavily veined, margins entire, each valve with a **tubercle;** tubercles prominent, lanceolate to subulate, surface papillate, wrinkled, each grain with its base extending slightly below the base of the perianth, about ⅔ the length of the valve; **outer sepals** oblanceolate, slender on female flowers, obovate and much like the inner perianth on male flowers; **bracts** reduced, dark-veined, hyaline, disintegrating to fibers; **inflorescence** an open panicle of ascending racemes of drooping flowers, leafless, 20–40 cm. long; **pedicels** sharply deflexed and jointed near the base, 10–15 mm. long (2–5 times the length of the perianth); **leaves** narrowly to broadly lanceolate, petioled, up to 40 cm. by 5 cm., flat, margins entire or nearly so; **petioles** spongy; **stipules** scarious or hyaline, disintegrating to brown fibers; **nodes** scarcely swollen; **stems** usually single, erect (sometimes decumbent at base) 40–150 cm. tall, from a stout, deeply penetrating perennial **root;** sometimes rooting adventitiously at the **lower nodes** ($2n = 60$).

Importance: Sometimes boiled as pot-greens, especially in the Southeastern United States; prepared much as the Giant Water Dock of Europe *(R. hydrolapathum* Huds.) with a double boiling, throwing away the first water.





9. *Rumex pallidus* Bigel.

Common Names: White Dock, Seabeach Dock

Type Description: Bigelow, Fl. Bost., Ed. 3, p. 153, 1840

Origin: Native of Canada and Northeasternmost United States

Habitats: Shorelines, rocky and sandy coasts of salt and brackish waters and inland waterways

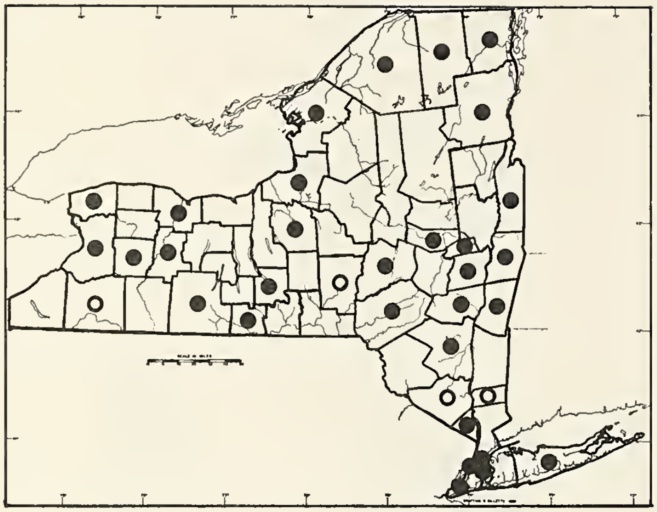
Habit: Erect or sprawling perennial

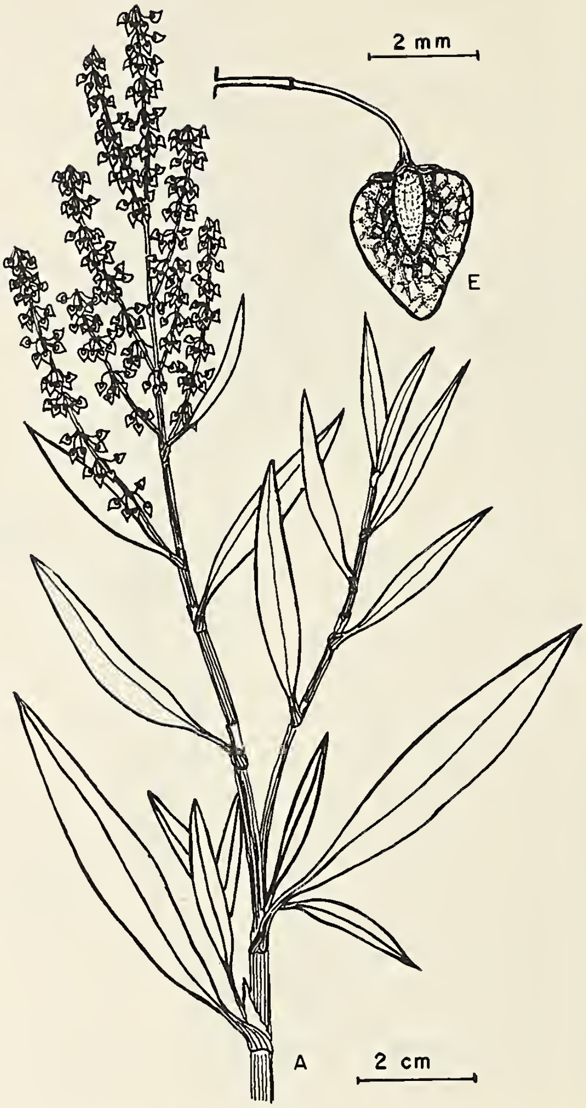
Flowering: June–August

General Distribution: Mostly coastal from Newfoundland south to New England

Description: Plants monoecious (androgynous); **stigmas** 3, stellate-branched; **styles** 3, short, deflexed; **ovary** 1, becoming a 3-angled **achene**; achene dark brown, strongly angled and slightly winged, about 2.5 mm. long, 1.1–1.2 mm. broad; **stamens** 6: filaments short, anther sacs yellowish not exceeding the perianth; **fruiting perianth** with deltoid-ovate **valves,** 3–4 mm. long, whitish to straw colored, with rounded bases and obtuse tips, margins entire, faces reticulately veined, and all valves with **tubercles;** tubercles large, ovoid-turgid, slightly pitted, yellowish to reddish with blunt tips, nearly as long as the valve and more than ½ as wide; **female outer perianth** of lanceolate sepals, ca. 2 mm. long; **bracts** reduced to short, hyaline or reddish brown sheaths; **inflorescence** 10–20 cm. long, a panicle of widely divergent fascicled racemes; **pedicels** shorter than the fruiting perianth (2–4 mm. long), visibly jointed just above the base; **leaves** glabrous, glaucous, petioled, lateral veins inconspicuous, undersurface of leaves minutely papillate; **lower leaves** narrowly oblong to lanceolate, flat, 10–20 cm. long, 1.3–2.5 cm. wide, bases somewhat acute to long-cuneate; **upper leaves** narrower, short petioled; **petioles** glabrous,ribbed; **stipules** fragile; **nodes** slightly swollen; **stems** several from a common base or the lower axils, slender flexuous, procumbent to arcuate-ascending, slenderly ribbed, 30–70 cm. long, from a large, whitish, wooly, perennial **root** (2n = 20).

Note: All specimens seen to date from New York have been atypical, showing some degree of intermediacy with *R. triangulivalvis*.





10. Rumex triangulivalvis (Dans.) Rech. f.

Common Name: Willow-leaved Dock

Type Description: Fedde Rep. Sp. Nov. 40, p. 297, 1936

Synonyms: *R. mexicanus* Meissn. (in part), *R. salicifolius* Weinm. ssp. *triangulivalvis* Dans.

Origin: Native of Western United States, spreading as a weed

Habitats: Waste places, moist, often brackish soils

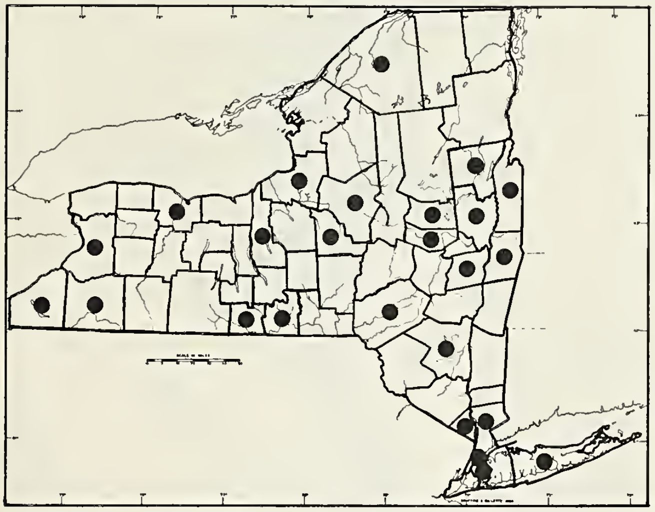
Habit: Erect perennial

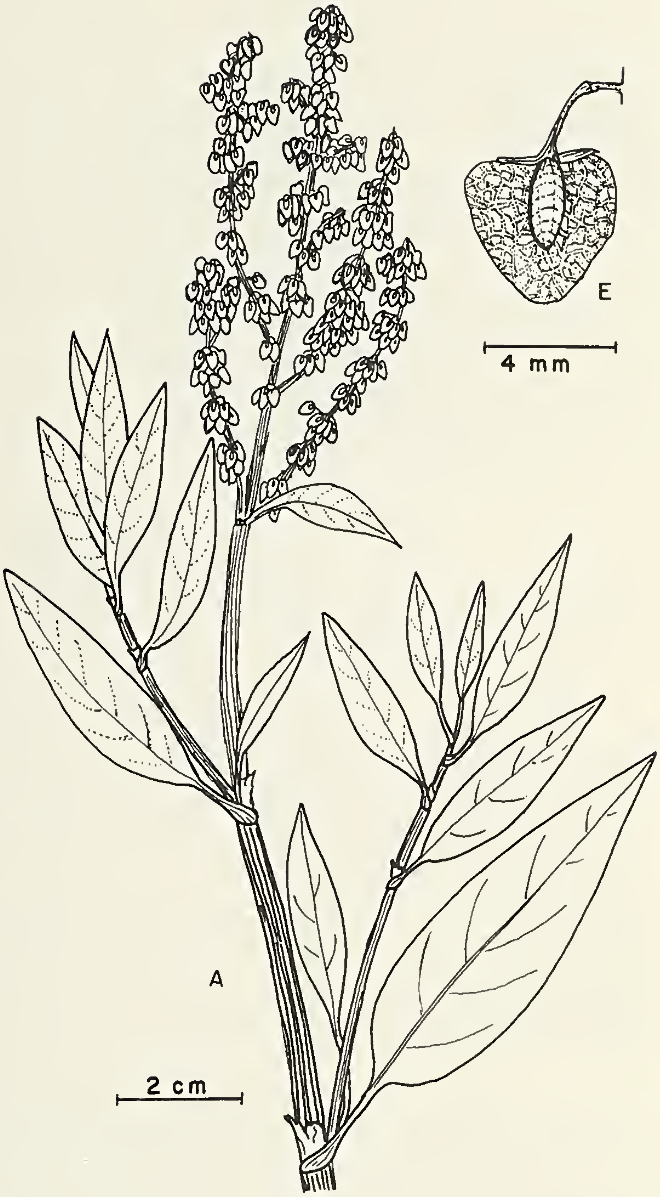
Flowering: June–August

General Distribution: Boreal North American from the west coast to Long Island

Description: Plants monoecious (androgynous); **stigmas** 3, stellate-fimbriate; **styles** 3, deflexed; **ovary** 1, becoming a 3-angled **achene**; achene, dark brown to nearly black, ovoid, 2 mm. long by 1.3 mm. wide; **stamens** 6: filaments short, anther sacs shorter than perianth parts, yellowish; **valves** about 3 mm. long, 2.5–3 mm. wide, triangular-deltoid with subcordate bases, margins entire to denticulate or irregularly crenulate, valve face olive to reddish-brown, reticulate veined, all valves usually with equal tubercle development; **tubercles** plump, bases rounded, tips acute, 1.8–2.5 mm. long; **outer sepals** about 1.5 mm. long, not reflexed; **inflorescence** 10–30 cm. long, a panicle of fascicled racemes of slender-pediceled flowers; racemes often subtended by linear leaves; **pedicel** longer than the perianth, articulated near the base; **leaves** mostly cauline, though larger near the base, pale green, narrowly lanceolate, flat (rarely undulated); **lower leaves** 12–15 cm. long, about 2–3 cm. wide; **upper leaves** much reduced in size with shorter petioles or subsessile; **stipules** whitish to pale brown, soon dropping; **nodes** slightly swollen; **stem** freely branched in the lower axils, 20–60 cm. tall, brownish-purple, ascending to erect from a stout, perennial **root** (2n =20).

Infraspecific Variability: This species complex has produced problems for the systematist; plants are quite variable in perianth size and other characters. Long known as *R. mexicanus* Meissn., these plants range widely from Mexico to Canada in the western part of the continent, then across to the Northeastern United States. Typical *R. salicifolius* is a closely related species with small perianth size and western distribution. Western populations with large perianths have been reported as tetraploid, while widespread *R. triangulivalvis* is diploid. Hybridization studies (Sarkar, 1958) indicate extremely high fertility, at least to the F_1, within this species complex. *Rumex pallidus* is no doubt also involved, as it appears to be the eastern counterpart of *R. salicifolius*.





11. Rumex altissimus Wood

Common Names: Pale Dock, Tall Dock, Peach-leaved Dock

Type Description: Wood, Classbook Bot. Ed. 2, p. 477, 1847

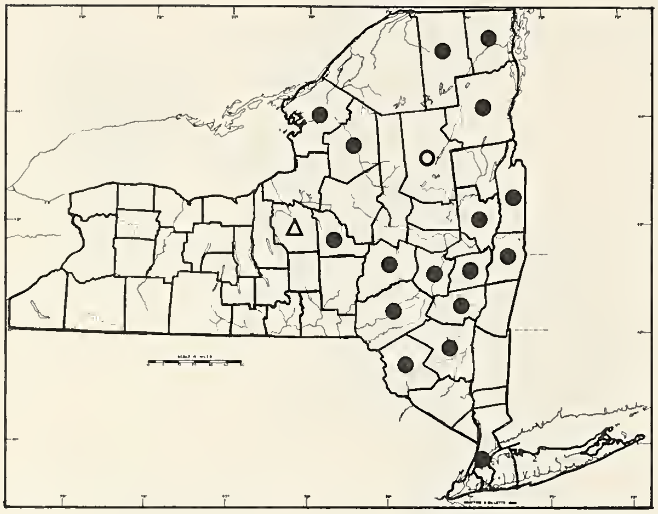
Origin: Native, Eastern United States

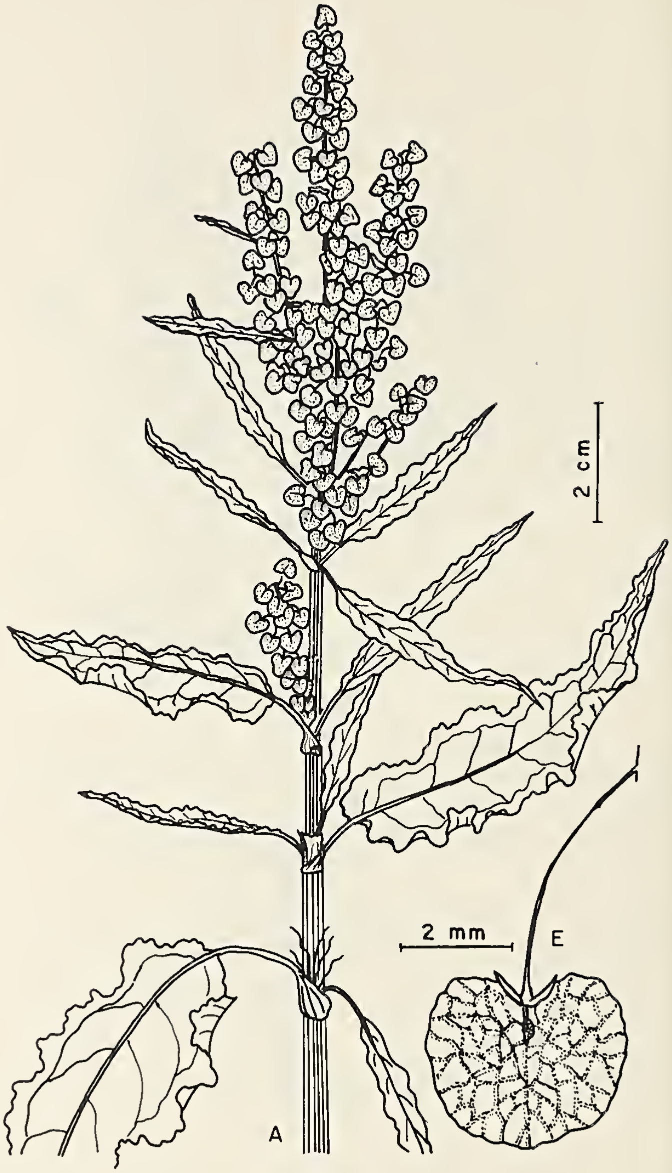
Habitats: Rich, often alluvial soils, stream and swamp margins

Habit: Branched, erect or ascending from a procumbent, perennial base

General Distribution: United States, mostly east of the Rockies; introduced into Europe

Description: Plants monoecious (androgynous); **stigmas** 3, stellate-fimbriate; **styles** 3, deflexed; **ovary** 1, becoming a 3-angled **achene;** achene strongly angled to somewhat winged, dark brown, ca. 3 mm. long; **stamens** 6: filaments short, anther sacs about equal in length to the perianth; **valves** acute to obtuse tipped, truncated or cordate at the base, with entire margins and reticulated surfaces, olive to reddish-brown in color; usually only one valve with a tubercle; **tubercle** ovate-fusiform, prominent, wrinkled or smooth; **bracts** reduced to small, lacerate, refuscent to hyaline sheaths; **inflorescence** a panicle of dense, upright, spikelike racemes of whorled fascicles, about 5–35 cm. long, leafless or nearly so; **pedicels** jointed, shorter than the perianth in fruit; **leaves** ovate to oblong-lanceolate, 7–15 cm. long, short petioled; **stipules** prominent, chartaceous, lacerate; **nodes** barely swollen; **stems** strongly ribbed, reddish-brown (including petiole bases) 50 cm. to a meter tall from a tough, perennial **root** (2n = 20).

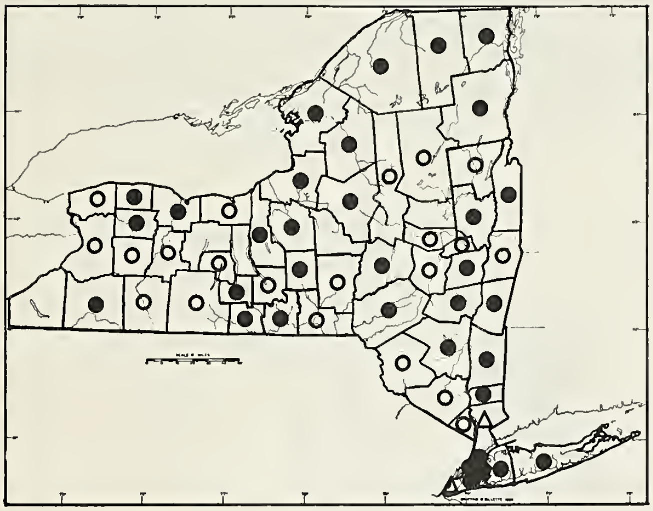


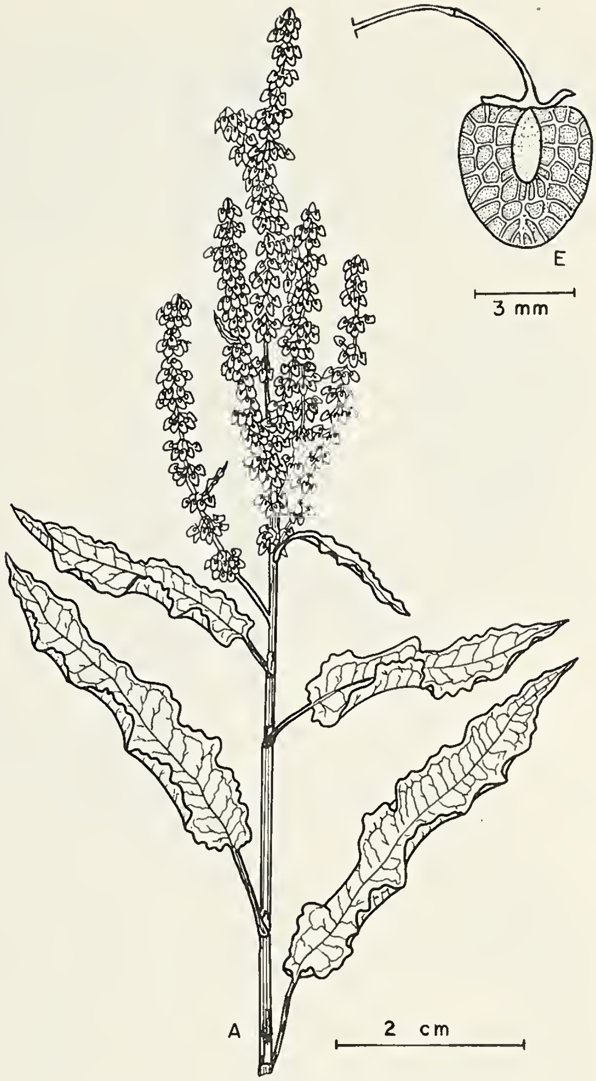


12. Rumex longifolius DC.

Common Name: Yard Dock
Type Description: DeCandolle, in Fl. Fr. Suppl., p. 368, Lambert and DC., 1815
Synonym: *Rumex domesticus* Hartm.
Origin: Northern Europe
Habit: Coarse, erect perennial
Habitat: Disturbed sites
Flowering: Late June–October
General Distribution: Circumboreal

Description: Plants with bisexual (protandrous) flowers; **stigmas** 3, stellate-fimbriate; **styles** 3, deflexed; **ovary** 1, becoming a 3-angled **achene;** achene dark brown, 2.3–3 mm. long, smooth-shiny, base stipitate, apex acute; **stamens** 6: filaments short, anther sacs yellowish, dehiscing longitudinally, shorter than perianth; **valves** reniform-ovate, definitely as broad as, or broader than long, often cordate, 4–7 mm. long, strongly reticulate-veined with entire or minutely crenulate margins; usually all valves **without tubercles**, occasionally one with a small poorly developed globular grain; **outer sepals** about 1.5 mm. long, not reflexed; **inflorescence** an elongate panicle of erect, dense racemes of tightly whorled flowers, leafy **bracteate** to near middle; **pedicels** slender, flexuous, jointed well below middle, up to 2.4 times as long as the valves; **leaves** crisped, undulate or flat; **lower leaves** narrowly oblong, oblong-ovate, oblong-lanceolate, up to 80 cm. long, widest near the middle, 3–5 times as long as broad, base acute, squared or rounded; **petioles** long, ribbed, somewhat ligulate; **upper leaves** narrower, shorter petioled, mostly with cuneate bases; **nodes** slightly swollen, with **stipules** which disintegrate to fibers with age; **stem** ribbed, simple below inflorescence, 20–150 cm. tall; **taproot** long, simple, perennial (2n = 40, 60).





13. Rumex crispus L.

Common Names: Curly Dock, Yellow Dock, Sour Dock

Type Description: Linnaeus, Species Pl., p. 335, 1753

Origin: Eurasia

Habitats: Disturbed soil, waste places, roadside ditches

Habit: Coarse, erect perennial with strongly crisped leaves

Flowering: May–September

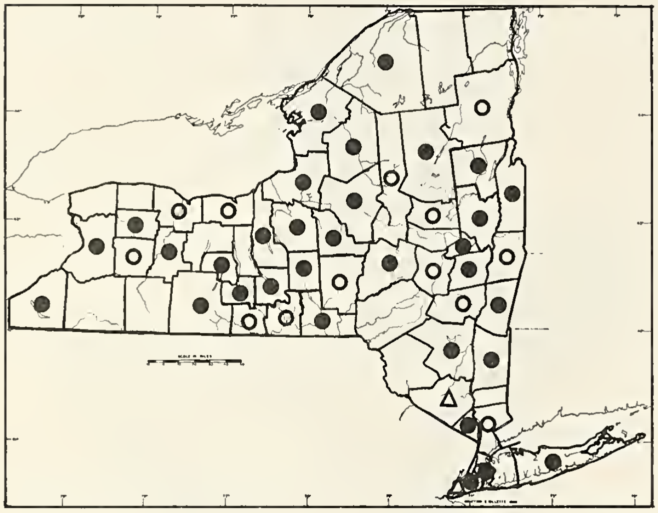
General Distribution: Cosmopolitan weed

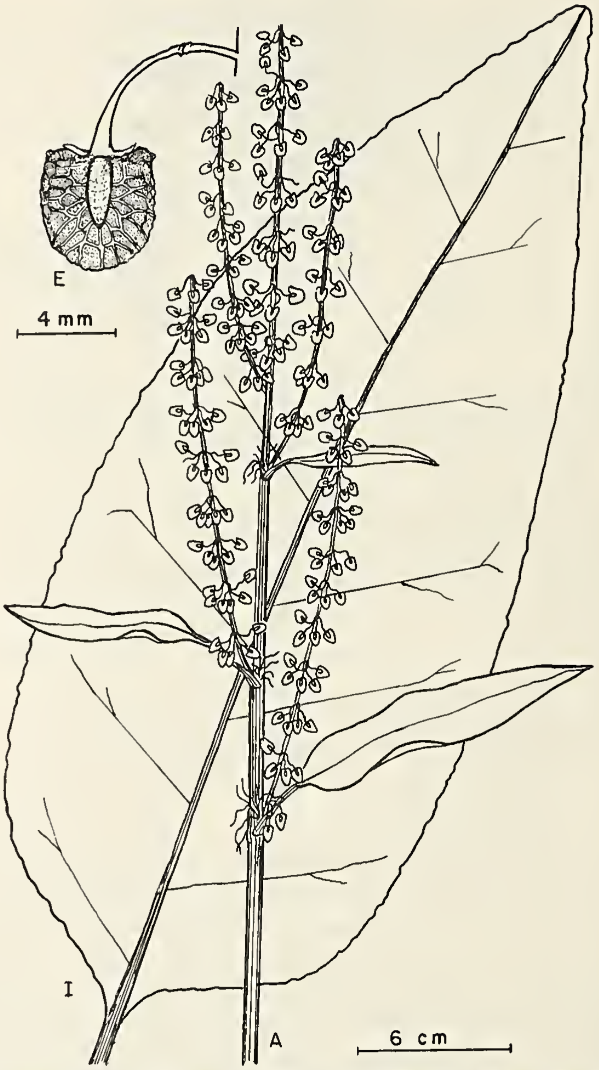
Description: Plants with bisexual (protandrous) flowers; **stigmas** 3, stellate-fimbriate; **styles** 3, deflexed; **ovary** 1, becoming a 3-angled **achene**; achene reddish-brown, 2–2.5 cm. long, smooth-shiny, slightly stipitate, tapering to a short, pointed apex; **stamens** 6: filaments short, anther sacs yellowish, dehiscing longitudinally, shorter than the perianth; **valves** broadly ovate to slightly deltoid; 4–5 mm. long and about as wide, reticulate with entire or minutely erose margins; usually all 3 valves with **tubercles**, occasionally only one; grain size sometimes unequal, the largest tubercle elliptic, turgid, pitted, ½ the length of the valve; **outer sepals** about 1.5 mm. long, not reflexed; **inflorescence** an elongate panicle of dense, slender racemes of tightly whorled flowers, leafy bracteate to near middle; **pedicels** slender, flexuous, jointed just below the middle, 5–10 mm. long; leaves with strongly crisped margins; **lower leaves** 10–30 cm. long, base cuneate to subcordate, their **petioles** long, often pubescent, ribbed on upper surface; **upper leaves** smaller, narrower, with obtuse bases for the most part; **nodes** slightly swollen, with **stipules** that disintegrate with age; stems ribbed, simple below the inflorescence, 30–160 cm. tall; **roots** 6–20 cm. long, brownish with pale interior, usually unbranched, perennial (2n = 60).

Infraspecific Variation and Hybridization: Two hybrids are reported from New York locations:

1) *Rumex crispus* X *obtusifolius* is recognized by its obvious teeth on the margins of the valves of the fruiting perianth; this hybrid has been reported only occasionally (probably a pentaploid).
2) *Rumex crispus* X *patientia* is intermediate in valve size between the two species, making the valve to tubercle-length ratio higher; the fruits are larger than those of *R. crispus*, but the leaves are variously crisped and undulated.

Importance: *Rumex crispus* has been used occasionally as a pot-green with double and triple boiling and decanting; however, its main use has been medicinal; the root contains rumicin and chrysarobin, and is usually boiled down to a syrup; the syrup can be dried and encapsulated or taken in solutions of various kinds; the extract has astringent properties, being applied or taken internally for various kinds of bleeding, including lung conditions and hemorrhoids; it is variously prescribed in Europe for jaundice, bilious complaints and as a laxative; tinctures from the flowers and seeds are taken for throat roughness, and variously applied to the body to relieve itching of skin conditions; it has even been used in the treatment of cancer and diptheria cases, where it is said to delay the enfeebled condition. As in many cases of popular folk medicine, most of these claims should be carefully scrutinized.

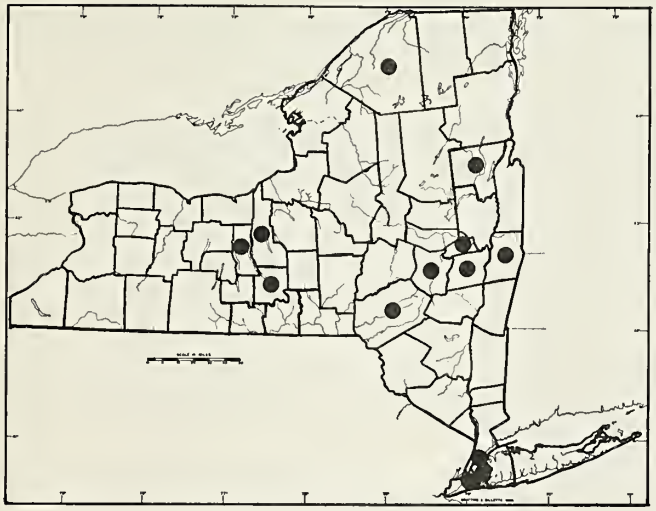


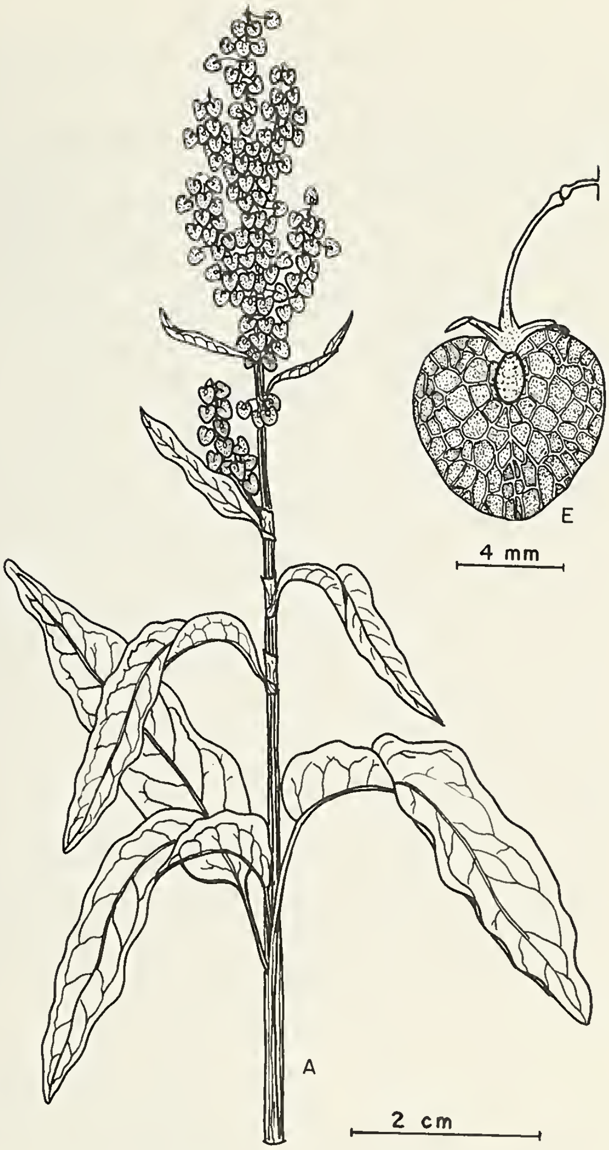


14. ***Rumex orbiculatus*** Gray

Common Name: Great Water Dock
Type Description: Gray's Man. Bot. Ed. 5, p. 420, 1867
Synonyms: *R. britannica* L. *R. hydrolapathum* var. *americanum* Gray
Origin: United States and Canada
Habitats: Swamps, wetlands and meadows
Habit: Large, coarse, erect perennial
Flowering: June–September
General Distribution: Wet lowlands of Newfoundland south to Ohio and west to Nebraska

Description: Plants monoecious (androgynous); **stigmas** 3, stellate-fimbriate; **styles** 3, deflexed; **ovary** 1, becoming a 3-angled **achene**; achene brown, strongly 3-angled to slightly winged, ±3.5 mm. long, stipitate at base; **stamens** 6: filaments short, anther sacs yellowish to reddish, slightly shorter than perianth segments; **valves** orbicular in fruit, 5–7 mm. long, 4.5–7 mm. wide, reddish brown, rigidly membranous with prominent reticulations, base truncated, apex rounded to obtuse, margins more or less entire or rarely with a few small teeth; each valve with a **tubercle** which is narrowly lanceolate, wrinkled on the sides and about ½ as long as the valves; **outer sepals** (female) 2–2.5 mm. long, lance-ovate; **bracts** reduced to scarious sheaths which disintegrate to fibers; **inflorescence** an elongate panicle; **pedicels** slender 6–9 mm. long, jointed in the lower fourth near the base (obscurely); **leaves** glabrous, slightly leathery, variable in size and shape at different positions on the plant, mostly oblong-lanceolate, up to 50 cm. long, bases usually truncated and tips obtuse to acute; **middle and upper leaves** narrower, linear toward the inflorescence; **leaf margins** minutely irregular to crenulate, flat, undulate or crisped; **midribs and petioles** often ribbed and reddish or purplish; **base of petiole** strongly clasping the stem; **stipules** large, brownish, disintegrating into dark fibers; **nodes** somewhat swollen; **stem** stout, rigid, usually ribbed, up to 2.5 m. in height, often inundated at base, arising from a stout, yellowish **root** with thick lateral branches (2n = 60).





15. *Rumex patientia* L.

Common Names: Patience, Monk's Rhubarb, Passion Dock, Patience Dock
Type Description: Linnaeus, Species Pl., p. 333, 1753
Origin: Southeastern Europe and Asia
Habitats: Waste places, roadsides
Habit: Robust, sometimes very tall, erect perennial
Flowering: May–August
General Distribution: Northeastern United States and Canada to the Midwest (naturalized)

Description: Plants with bisexual flowers (protandrous); **stigmas** 3, stellate-fimbriate; **styles** 3, deflexed; **ovary** 1, becoming a 3-angled **achene**; achene dark reddish brown, broadest slightly below the middle, base slightly stipitate, ca. 3 mm. long; **stamens** 6: filaments short, anther sacs yellowish, shorter than the lobes of the perianth; **valves** broadly rounded, 5–9 (10) mm. long, reddish to brown at maturity, with minutely denticulate margins, usually only one valve bearing a small **tubercle**; tubercle ⅓ the length of the valve or less; **outer sepals** 1.5–2.0 mm. long, reflexed in fruit; **pedicels** slender, jointed below the middle, 5–10 mm. long; **bracts** scarious, sheathing; **inflorescence** a stout, elongate panicle with ascending branches of fascicles, 25–70 (90) cm. long, with some small leaves; **leaves** glabrous, pale green, broadest below the middle, up to 35 cm. long by 15 cm. wide, margins only undulating or slightly crisped (except in hybrids); **lower leaves** ovate-oblong to oblong-lanceolate with truncate bases; **petioles** flat on upper side; **stipules** brownish to hyaline, becoming lacerated; **nodes** somewhat swollen; stems very stout, ribbed, usually unbranched below the inflorescence, up to 3 m. tall, usually arising from a single stout perennial **root** (2n = 60).

Infraspecific Variation: Known to hybridize with Curly Dock (See under *R. crispus*)

Importance: Like many Docks it has been used for its astringent properties as a treatment for bleeding and as a mild laxative; it is boiled with one or two decantings of the pot water and eaten as a green vegetable.

Note: *Rumex sanguineus* L. is reported by House (1924) and others as a waif. Specimens have not been seen which verify its establishment in the State. Young plants of *R. obtusifolious* often have bright red veins, and these are sometimes mistaken for *R. sanguineus*.

3. POLYGONUM

Common Names: Knotweed, Smartweed, Bindweed, Tearthumb
A genus with worldwide distribution in wetlands and disturbed soils. There are over 30 native and introduced species in New York, representing seven major subgenera. The plants are mostly herbaceous annuals or perennials; some species are vines or subshrubs, reaching a height of 4 m.

Description: Flowers bisexual or functionally unisexual (cleistogamous to mechanically heterostyled); **plants** totally bisexual, dioecious or polygamous; **stigmas** capitate, 2–3 at style tips or sessile; **styles** 2–3, separate, fused or obsolete; **ovary** unilocular, 2–3 angled, with a single orthotropous **ovule** in one of its angles; **placentation** basal; **fruit** an **achene,** 2–3 (4) angled or turgidly lenticular, acute to obtuse at the apex, acute to obtuse at the base, sometimes stipitate, yellow-green to brown to black, surface pebbly to highly glossy; achene enclosed or exserted from the persistent perianth; **seed** conforming to the achene shape in fruit; **embryo** in a groove, curving around the mealy to albuminous **endosperm** in one angle of the fruit; **stamens** 3–9, sometimes associated with a basal **glandular disc; filaments** linear or in the inner ones dilated, **anther sacs** greenish, yellow to red-purple dehiscing by longitudinal slits; **perianth** petaloid, deeply or shallowly 4–5 lobed, with a somewhat connate base; **outer lobes** usually enclosing the inner in fruit, with cucullate tips in many native species, greenish to white, pink, red or red-purple, midvein obscure to prominent, or rarely expanded into a wing in fruit; **inner lobes** similar in color and shape, subequal or reduced; **pedicels** included in bracts or exserted (rarely deflexed), 2 or more joined alternately on short peduncles to form fascicles; **fascicles** borne in the axils of sheathing; **bracts** (ocreolae) obtuse to truncate, tubular sheathing with entire or ciliate margins, overlapping or remote; **inflorescences** of simple fascicles scattered on the plant, or more often organized into panicles which simulate spikes, racemes and capitate heads; **leaves** simple, alternate, entire (rarely crenulate) with a wide range of shapes from cordate to linear, glabrous to copiously pubescent or glandular, with **petioles** which may reach many cm. in length, or sessile and jointed to the **stipules;** stipules two-lobed or tubular and sheathing (ocreae), often shattering with age, leaving a fibrous residue, glabrous to coarsely pubescent or glandular; some species with a flange or ring of bristles at the upper stipule margin; stipules joined to the petioles at or above the node level; **nodes** often swollen; **internodes** smooth to fluted, variously glabrous to pubescent or glandular (including so-called "peduncles" in the inflorescence); **stems** green or pink to brownish-red or orange, creeping, spreading or erect to vining or sprawling in water, arising from annual, biennial or perennial **taproots** or from creeping **rhizomes** or **stolons.**

KEY TO SPECIES OF POLYGONUM

1. Stems prickly with spines or hooked barbs ....(2)
1. Stems not prickly (stipules may have bristles) ....(3)
    2. Leaves hastate; flowers in small racemes; achene lens-shaped ....1. *P. arifolium* (p. 23)
    2. Leaves sagittate; flowers in capitate heads; achenes 3-angled ....2. *P. sagittatum* (p. 24)
3. Outer perianth winged or keeled in fruit; vines or robust subshrubs ....(4)
3. Outer perianth not winged or strongly keeled in fruit; annual or perennial herbs ....(8)
    4. Plants viney, twining or sprawling; erect only when young or depauperate ....(6)
    4. Plants tall and erect or ascending (up to 3 m.) ....(5)
5. Leaves truncate at the base, abruptly acuminated at the tips, mostly 5–10 cm. long....3. *P. cuspidatum* (p. 25)
5. Leaves cordate at the base, more tapered at the tip, mostly 12–20 cm. in length.......4. *P. sachalinense* (p. 26)
    6. Perianth lobes merely keeled, not strongly winged in fruit ....(7)
    6. Perianth lobes strongly winged ....5. *P. scandens* (p. 27)
7. Reflexed bristles present at the base of the stipules; styles not united ....6. *P. cilinode* (p. 29)
7. Reflexed bristles absent; styles united ....7. *P. convolvulus* (p. 30)
    8. Flowers mostly drooping in fruit on deflexed pedicels; spikes slender and much interrupted ....(9)
    8. Flowers mostly erect or ascending; inflorescences various ....(10)
9. Styles 2, rigid, persistent and elongated with hooks at the tips; lower leaves 5–15 cm. long ....8. *P. virginianum* (p. 31)
9. Styles 3, soon deciduous; leaves less than 5 cm. long ....9. *P. douglasii* (p. 32)

10. Leaves with two obvious longitudinal folds (plicate) on the narrowly lanceolate blades..10. *P. tenue* (p. 33)
10. Leaves not plicate........(11)
11. Flowers in spike-like panicles or capitate heads; inflorescence not leafy; pedicels smoothly joined to the tubular stipules, not jointed at the leaf bases........(24)
11. Flowers in small fascicles, often scattered, and subtended by leaves or foliacious bracts; leaves jointed to the stem at the base of the stipules which are oblique and usually early shattering........(12)
12. Tips on the perianth lobes longer than the achene in most flowers, enclosing the achene at maturity....(19)
12. Tips of the perianth equal to the achene length or shorter, not enclosing it completely........(13)
13. Plants conspicuously heterophyllous; flowers crowded among the smaller leaves and bracts near the branch tips........(14)
13. Plants not obviously heterophyllous; the subequal leaves grading in size through the season; flower clusters generally scattered throughout........(15)
14. Many achenes conspicuously exserted, pale brown to greenish and smooth; plants erect to procumbent........11. *P. ramosissimum* (p. 34)
14. Most achenes not conspicuously exserted, pebbly brown; plants wiry, sprawling....12. *P. aviculare* (p. 36)
15. Plants distinctly glaucous; stipules persistent, silvery-membranaceous above, conspicuous, up to 1 cm. long........13. *P. glaucum* (p. 37)
15. Plants only slightly glaucous (or mildewed); stipules not persistent or conspicuous, soon shattering........(16)
16. Leaves ovate to elongate-elliptic, mostly 2–4 times as long as broad........(17)
16. Leaves 5–9 times longer than broad, oblanceolate to lance-linear........(18)
17. Outer perianth lobes elongate, curved, with boat-shaped (cucullate) tips, often slightly keeled; perianth about 3.5 mm. long at maturity, parted above the middle........14. *P. achoreum* (p. 38)
17. Outer perianth lobes flat or flared, not curved-cucullate, without a keel; perianth generally less than 3.0 mm. long (excluding the achene), parted to about the middle........15. *P. arenastrum* (p. 39)
18. Leaves oblanceolate with rounded tips; plants branching profusely (natives; often in salt marshes)........15. *P. ramosissimum* (p. 34)
18. Leaves lanceolate to linear with acuminate tips (sometimes minutely blunted), not rounded; lateral branching less profuse (weeds of fields and roadsides)........16. *P. neglectum* (p. 40)
19. Outer perianth lobes boat-shaped (with cucullate tips)........(21)
19. Outer perianth lobes not cucullate........(20)
20. Plants markedly heterophyllous; perianth divided to below the middle; achenes with 2–3 concave sides; plants spreading........12. *P. aviculare* (p. 36)
20. Plants with subequal leaves; perianth not divided below the middle; achenes usually with one sharply concave and two convex sides; plants often forming cespitose mats on gravel and streets........15. *P. arenastrum* (p. 39)
21. Leaves lanceolate, oblanceolate or linear, 4–12 times longer than broad........11. *P. ramosissimum* (p. 34)
21. Leaves oblong, oval or obovate, 2–3 times longer than broad........(22)
22. Plants strongly heterophyllous (except the very young); erect with ascending branches........17. *P. erectum* (p. 41)
22. Plants with subequal leaves throughout; erect when young, but sprawling and mat-forming with age....(23)
23. Perianth parted to below the middle; not strongly constricted above the achene........18. *P. buxiforme* (p. 42)
23. Perianth parted less than halfway, constricted to form a neck above the achene........14. *P. achoreum* (p. 38)
24. Leaf blades extending down the petioles to form wings which clasp the stem at their bases........19. *P. nepalense* (p. 43)
24. Leaf blades not extending down the petioles........(25)
25. Tubular stipules of the middle and upper leaves with a distinct ring of marginal bristles........(28)
25. Tubular stipules entire or shattering, without marginal bristles, though their surfaces may be quite pubescent........(26)
26. Perennials with horizontal rhizomes or aquatic stolons; inflorescences usually solitary (or paired) at the apex of each major branch........20. *P. amphibium* (p. 44)
26. Annuals with taproots; inflorescences two, or usually more, per apex........(27)

27. Perianth with conspicuous, raised veins shaped like inverted anchors; perianth lobes usually 4; inflorescences 1 cm. thick or less, sometimes nodding, greenish to pink-tinged .... 21. *P. lapathifolium* (p. 46)

27. Perianth without raised, anchor-shaped veins; perianth lobes 5; inflorescences usually 1 cm. or broader, not nodding, pink to rose (rarely greenish) .... 22. *P. pensylvanicum* (p. 47)

28. Perennial plants with horizontal rhizomes or stolons .... (33)

28. Annual plants with taproots .... (29)

29. Flowers with small yellow or brown glandular dots (visible with a hand lens and more pronounced after drying) .... 23. *P. hydropiper* (p. 48)

29. Flowers without glandular dots .... (30)

30. Leaves broadly ovate to cordate, mostly 5–10 cm. broad .... 24. *P. orientale* (p. 49)

30. Leaves ovate-lanceolate to linear, usually less than 5 cm. wide .... (31)

31. Peduncles and upper stem covered with stalked glands .... 25. *P. careyi* (p. 50)

31. Peduncles and upper stems without stalked glands .... (32)

32. Bristles of the inflorescence bracts 2–3.5 mm. long, often equaling or exceeding the flower tips .... 26. *P. cespitosum* (p. 51)

32. Bristles of the inflorescence bracts short or lacking .... 27. *P. persicaria* (p. 52)

33. Flowers with yellow to brown glandular dots that are numerous and randomly spaced (visible with a hand lens and more obvious after drying) .... (37)

33. Flowers without glands, or with a few scattered, pale, flat structures .... (34)

34. Achenes 3-angled; inflorescences several per main branch .... (35)

34. Achenes lens-shaped; inflorescences solitary (or paired) on the major shoots .... 20. *P. amphibium* (p. 44)

35. Fruiting perianth spherical in outline, the lobes incurved toward the slightly exserted achene .... 28. *P. opelousanum* (p. 53)

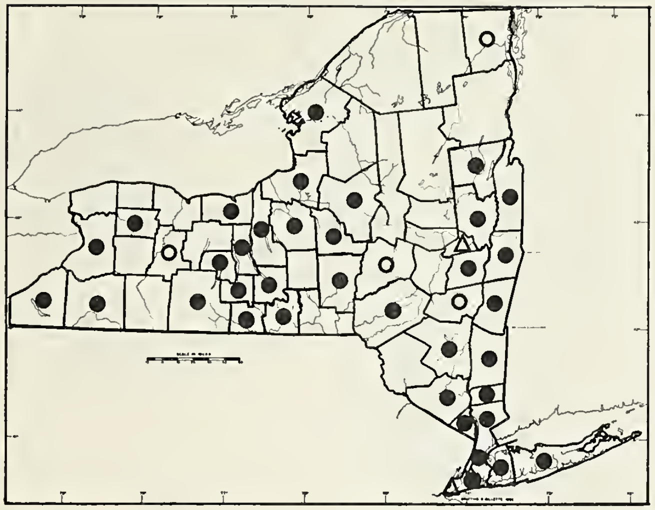
35. Fruiting perianth oval in outline, enclosing the achene completely at maturity .... (36)

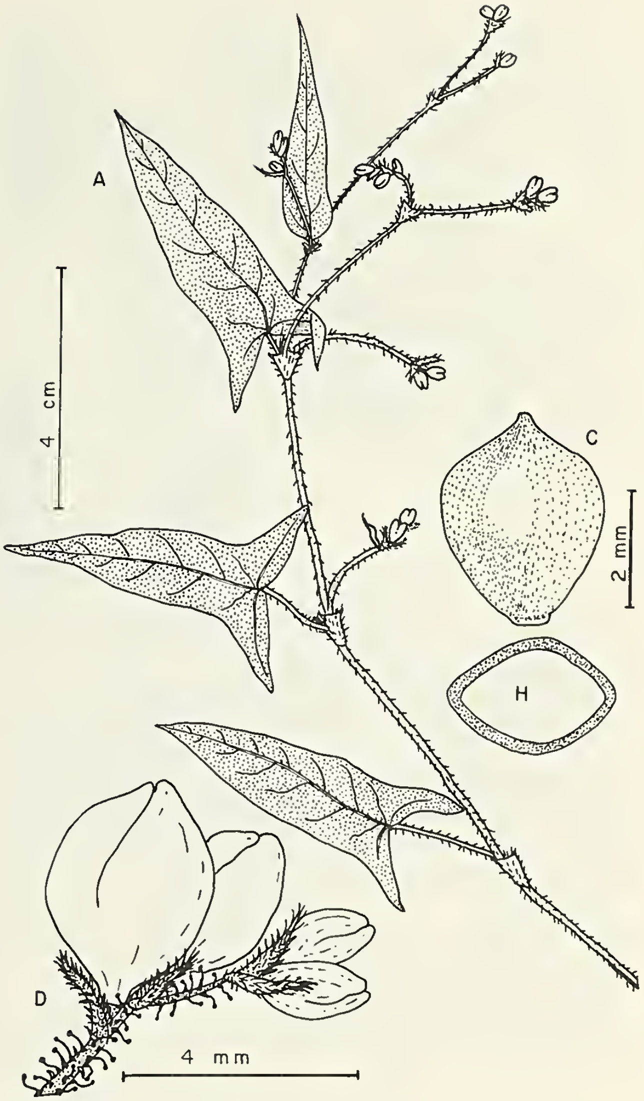
36. Flowers greenish-white to creamy tan; plants robust .... 29. *P. setaceum* (p. 54)

36. Flowers pink to rose (albinos rare); plants slender .... 30. *P. hydropiperoides* (p. 55)

37. Inflorescences continuous with more or less overlapping eciliate bracts and flowers; robust plants with leaves up to 4.5 cm. broad .... 31. *P. robustius* (p. 56)

37. Inflorescences frequently interrupted; bracts ciliate; wiry, slender plants with the larger leaves usually not exceeding 2.5 cm. in width .... 32. *P. punctatum* (p. 57)



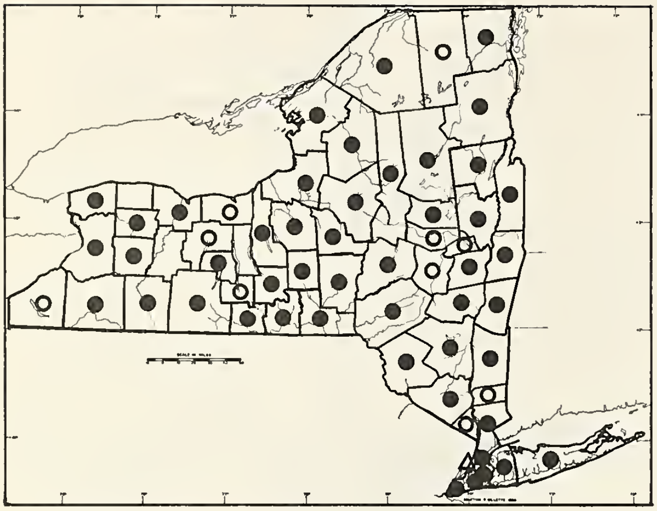


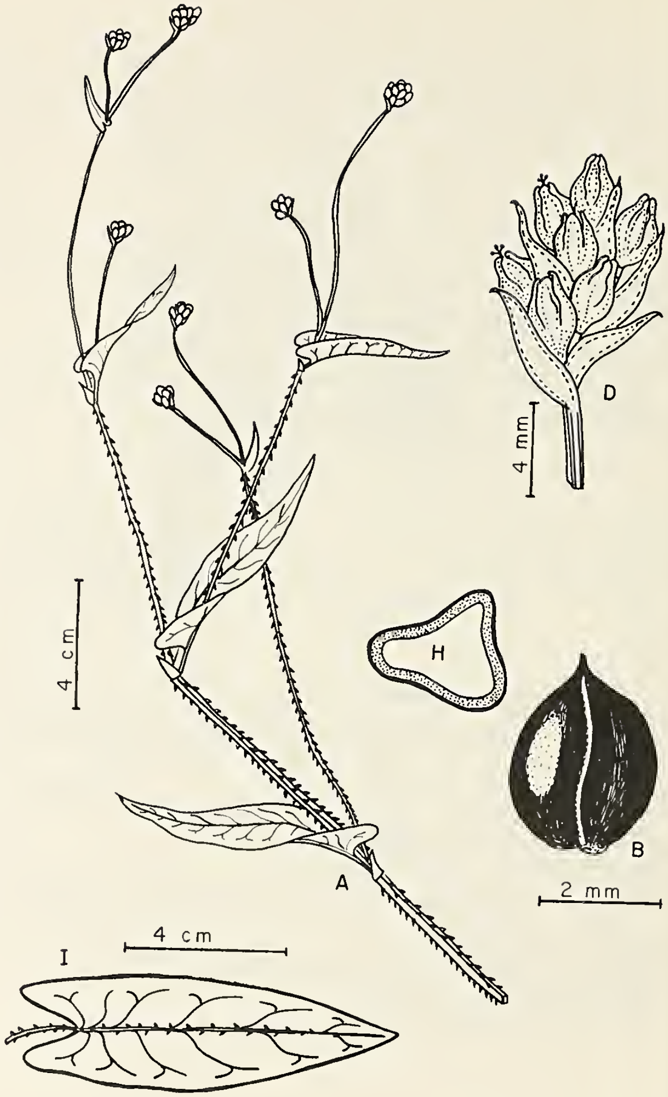
1. *Polygonum arifolium* L.

Common Names: Tearthumb, Halberd-leaved Tearthumb
Type Description: Linnaeus, Species Pl., p. 364, 1753
Synonym: *Tracaulon arifolium* (L.) Small
Origin: North America
Habitats: Rich, moist soil in sunny habitats, marshes and wet meadows
Habit: Scandent sprawling annual (perennial?)
Flowering: July–October
General Distribution: Eastern North America

Description: Plants with bisexual flowers; **stigmas** 2; **styles** 2, 0.5–0.6 mm. long; **ovary** 1, becoming a lens-shaped **achene;** achene biconvex, plump, obovoid or ovoid-oblong, 3.5–5 mm. long, surface dark brown to black, smooth, lustrous, apex obtuse, base stipitate, enclosed in the perianth; **stamens** 6–8, enclosed; **perianth** about 2.5 mm. long at anthesis, up to 6 mm. long in fruit, divided from below the middle into 4 lobes, greenish to pink, white or purplish; **bracts** funnelform, oblique, sheathing, glabrous, about 2 mm. long, associated with hispid-margined **reduced leaves; pedicels** about 2 mm. long, articulated at the perianth base; **inflorescences** both terminal and axillary, each being a few-flowered, short raceme or subcapitate cluster; **peduncles** 1–3 cm. long, hispid, axis often with glandular hairs in the upper portion and small retrorse prickles below; **leaves** 2–18 cm. long, 1–16 cm. wide, lower ones broadly hastate-cordate with 2 widely divergent, acuminate basal lobes, **upper leaves** lanceolate with sagittate, cordate or unlobed bases, upper and lower leaf surfaces pubescent, lower with small stellate hairs, margins hispid; midrib, principal veins and petioles often with retrorse **prickles; petioles** 1–2 cm. long; **stipules** sheathing, funnelform, oblique, .5–1 cm. long, lower portion with short prickles, upper margin bristly-ciliate; **nodes** slightly swollen; **internodes** 4-angled, channeled, armed with stout, retrorse **barbs; stems** simple or usually branched, scandent, 20–120 cm. long, arising from a fibrous **root system,** usually annual, but adventitiously rooting at lower nodes.

Importance: Like *P. sagittatum,* this species is most notable as a nuisance where it forms "briar patches."





2. *Polygonum sagittatum* L.

Common Names: Tearthumb, Arrow-vine, Scratch Grass

Type Description: Linnaeus, Species Pl., p. 363, 1753

Synonym: *Tracaulon sagittatum* (L.) Small

Origin: North America or Asia (Arctotertiary)

Habitats: Swampy areas, meadows, moist stream and lake banks

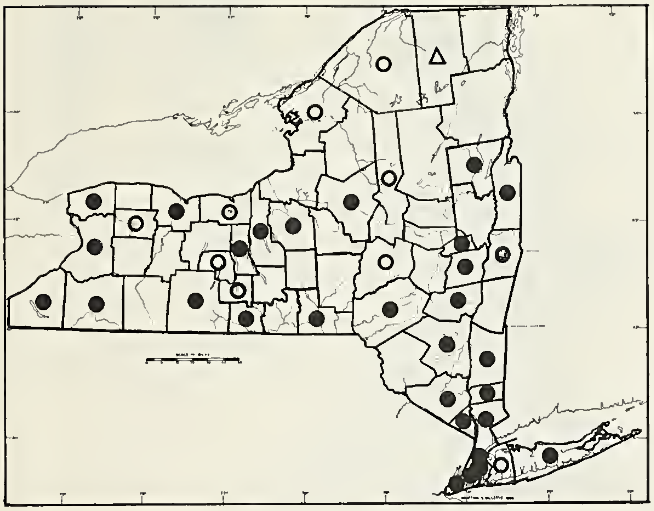
Habit: Scandent, spreading and drooping annual giving the appearance of a vine (perennial?)

Flowering: July–October

General Distribution: Eastern North America and Asia

Description: Plants with bisexual flowers; **stigmas** 3; **styles** 3, 1–1.5 mm. long; **ovary** 1, 3-angled, becoming a trigonous **achene;** achene 3–3.5 mm. long, with 3 ± equal sides, generally 2 slightly concave, ovoid in outline, apex acute, base stipitate, dark brown to black, smooth, lustrous, included; **stamens** 6–8, included in the perianth; **perianth** about 4 mm. long, divided from below the middle into 5 lobes, green and pink to red or white; **bracts** paired, chaff-like scales subtending and partially sheathing each flower and associated with a reduced leaf; **reduced leaves** narrow, lanceolate, 3–5 mm. long, hyaline margined, green, glabrous; **pedicels** ± 1.5 mm. long, jointed at the base of the perianth; **inflorescences** peduncled, terminal or axillary capitate clusters; **peduncles** glabrous, elongate; **leaves** lanceolate-sagittate, apex acute, 1–12 cm. long, 0.5–3.1 cm. wide, lower surface lighter green than the upper surface, margin ciliate or with small prickles, midrib and petioles with retrorse prickles or **barbs; petioles** 1–5 cm. long (longer on lowest leaves); **stipules** sheathing-oblique, 0.5–1 cm. long, hyaline, smooth, summit eciliate; **nodes** slightly swollen; **internodes** 4-angled, channeled, armed with stout, sharp, retrorse **prickles; stems** simple or branched, scandent, 30–200 cm. long, arising from a fibrous annual **root system** (adventitiously rooting occasionally from the lower nodes).

Importance: A rather undistinguished, sprawling plant, mostly noted for the irritating cuts which it can cause.



3. *Polygonum cuspidatum* Sieb. and Zucc.

Common Names: Japanese Bamboo, Japanese Knotweed, (Mexican Bamboo)

Type Description: Siebold and Zuccarini, Fl. Jap. Fam. Nat., 2: 84, 1846

Synonym: *P. zuccarinii* Small

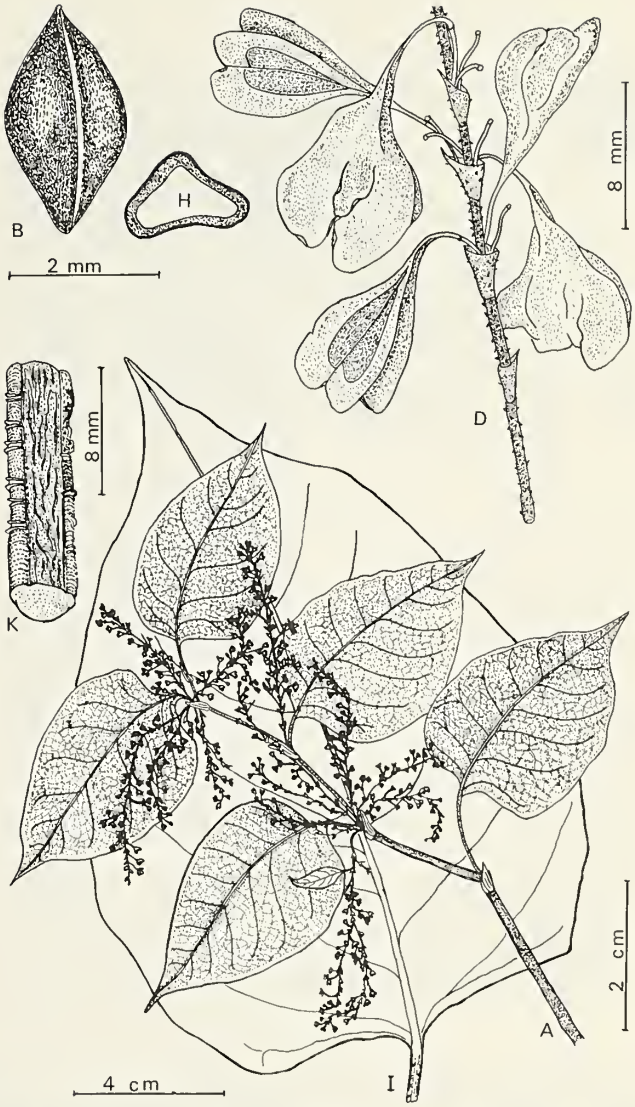
Origin: Eastern Asia

Habitats: Waste places, poorly tended gardens, etc.

Habit: Erect perennial, becoming quite tall

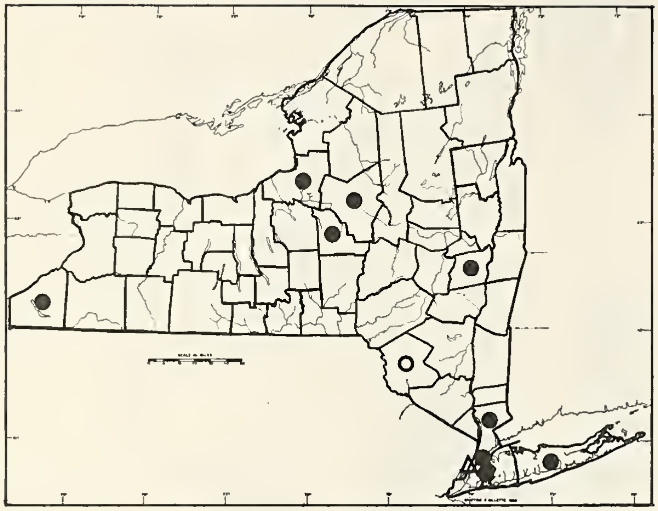
Flowering: July–September

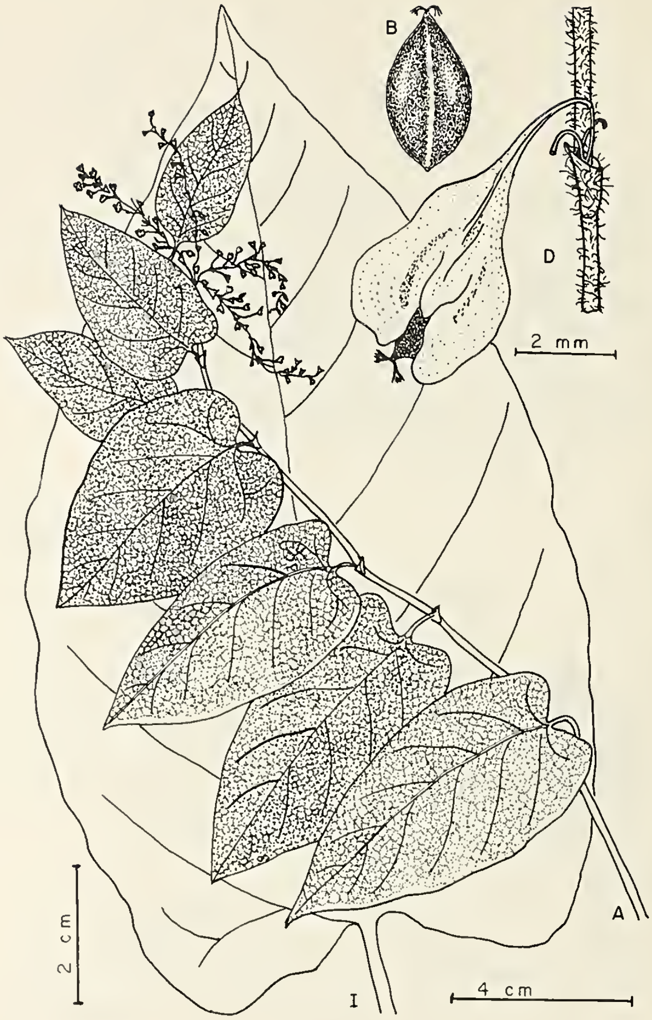
General Distribution: Asia (cultivated and escaping in Europe and North America)



Description: Plants functionally dioecious; stigmas 3; **styles** 3, short; **ovary** 1, becoming a 3-angled **achene;** achene about 3 mm. long, included in the persistent perianth, with 3 oblong, concave sides, apex acute, base acute and minutely stipitate, surface black, smooth and lustrous; **stamens** 8, anther sacs yellow, included; **perianth** parted below the middle into 5 greenish-white petaloid lobes, the outer 3 strongly cucullate, about 2 mm. long at anthesis, females expanding to 8–10 mm. long, and becoming strongly winged in fruit; **perianth wings** tapering nearly to the articulated pedicel-joint, **inner perianth** lobes short, not expanded greatly in fruit; **pedicel**s about 4 mm. long, jointed at about the middle; **bracts** funnelform, oblique, sheathing, dark with a few short flattened hairs on the surface; **inflorescence** a series of many-flowered, racemose panicles in the axils of the upper leaves, 6–12 cm. long, the axes with short, flat hairs; **leaves** broad, stiff, 5–15 cm. long, 2–10 cm. wide, ovate, the tips strongly attenuated or cuspidate, the bases truncate or cuneate in smaller leaves, minor venation strongly reticulate, leaf margins warty or minutely serrulate; **petioles** 1–3 cm. long with corky, lacerated ridges; **stipule**s often deciduous, dark, sheathing, glabrous and somewhat oblique; **node**s swollen; **internode**s terete or angular-channeled, glaucous, mottled, often warty; **stems** somewhat woody, zig-zag branched, 1–2.8 meters tall, erect, arising from a stout, rapidly growing **rhizome** (2n = 44?, 88).

Importance: These plants have some of the properties of true bamboo with regard to fast growth, horticultural usage and the problems they can cause when planted and then abandoned. As escapes from gardens and yards they can take over whole lots. They are quite hard to eradicate, since the cutting of rhizomes only propagates them. This seems to be particularly true on Long Island. Young shoots have been used as a food, cooked like asparagus or as a puree. They may also be used as a substitute for rhubarb with a specially prepared sour sauce.





4. *Polygonum sachalinense* F. Schmidt ex Maxim.

Common Names: Sachaline, Giant Knotweed

Type Description: J. Schmidt ex Maxim., Primit. Fl. Amur., p. 233, 1859

Origin: Japan and the Sachalin Islands

Habitats: Vacant lots, abandoned gardens, lawns, as an escape from cultivation

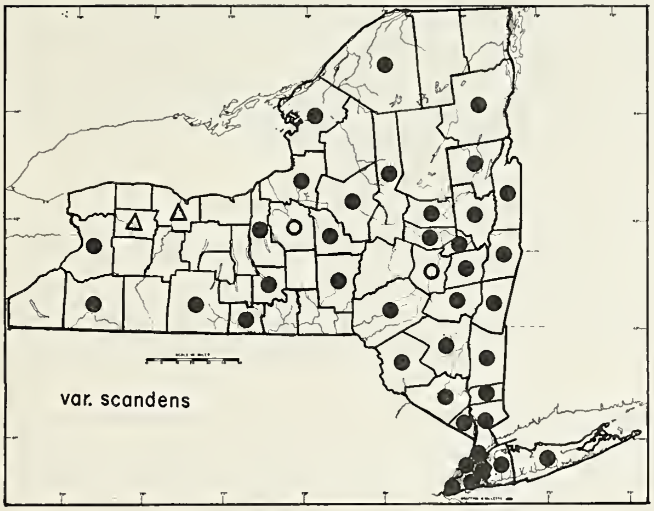
Habit: Giant, erect perennial, reaching 4 m. in height

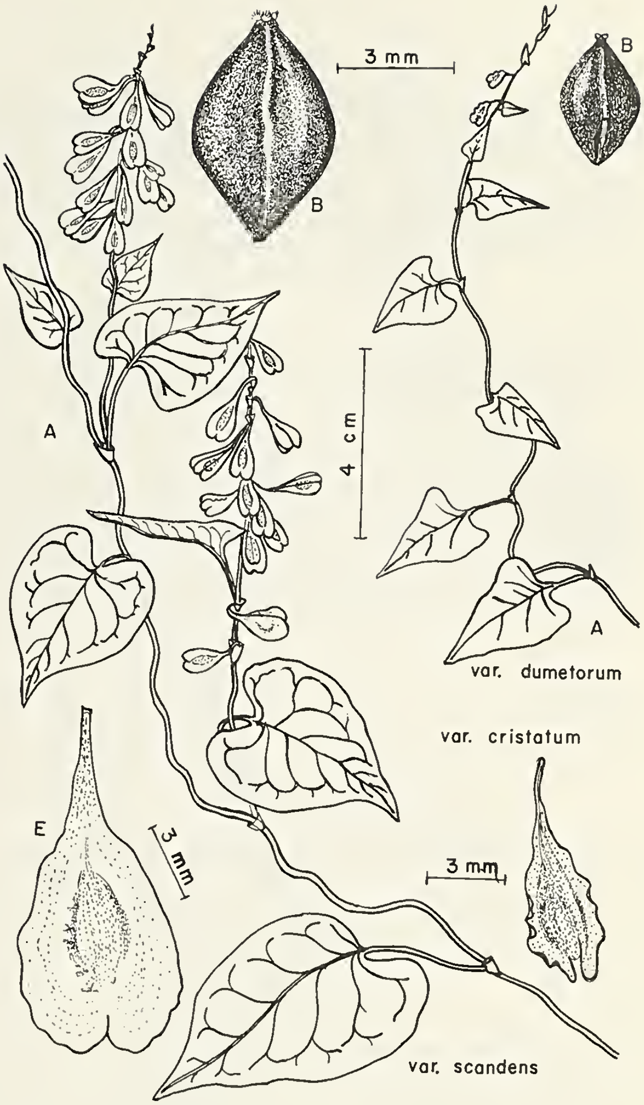
Flowering: July–October

General Distribution: Native in Asia, cultivated and escaping in Europe and North America

Description: Plants with bisexual flowers; **stigmas** 3, flared and lobed; **styles** 3, short; **ovary** 1, becoming a 3-angled **achene;** achene 2.8–3.2 mm. long, brown, lustrous, included in the perianth; **stamens** 6–8, shorter than the perianth, inner filaments dilated; **perianth** 3–4.5 (6) mm. long, greenish, 5-lobed to below the middle, with broad, pale wings which extend down the pedicel; **pedicels** 3–5 mm. long, jointed, winged above the joint contiguous with the flower; **bracts** sheathing-oblique, with acute tips, puberulent; **inflorescences** dense axillary panicles which are much-branched, often with over 100 flowers each; **peduncles** and other axes of the inflorescence densely pilose with thick, reddish hairs; **leaves** cordate-ovate with acute to acuminate tips, 10–30 cm. long, 7–20 cm. wide, glandular-punctate, lower surface puberulent along veins, glaucous; **petioles** reddish, slightly ribbed, 1–4 cm. long; **stipules** tubular-cylindric, reddish, glabrous, blending with the stem; **nodes** slightly swollen; **internodes** tough, reed-like, reddish brown, grooved; **stems** zig-zag branched, erect, up to 4 m. tall, from a woody, branched **rhizome** (2n = ca. 44).

Importance: This species was introduced after its discovery in the mid-19th century, lauded as a handsome ornamental. The U.S.D.A. (Lamson-Scribner, 1895) warned that it is an aggressive spreader to which "gravel walks are no obstacle." It was once recommended as a soil binder for riverbanks, but like Kudzu (*Pueraria*) in the south, its use can be unwise where it gets out of control. The plants reach a height of 4 m., and can become a serious problem. Young shoots are eaten by livestock, and plants have been added to silage in Russia.





5. *Polygonum scandens* L.

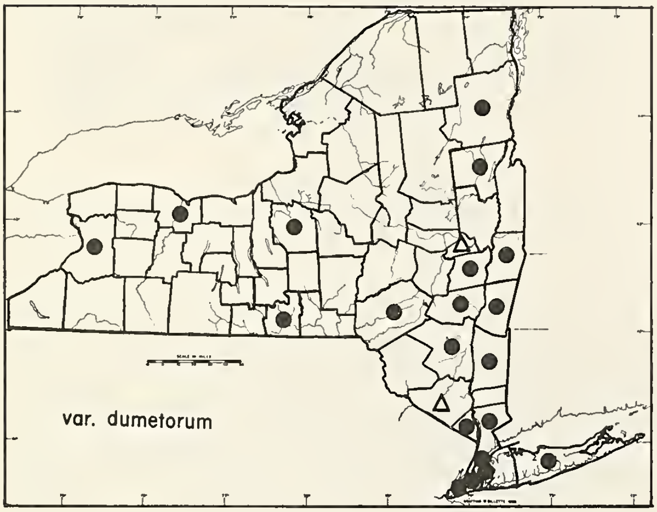
Common Name: (Climbing) False Buckwheat
Type Description: Linnaeus, Species Pl., p. 364, 1753
Synonyms: *P. dumetorum* L., *P. cristatum* Engelm. and Gray
Origin: Partly native, partly introduced from Europe
Habitats: Woods, thickets, fence rows and waste places, cultivated fields
Habit: Climbing and twining or sprawling
Flowering: July–November
General Distribution: Eastern and Central United States and Canada, Eurasia

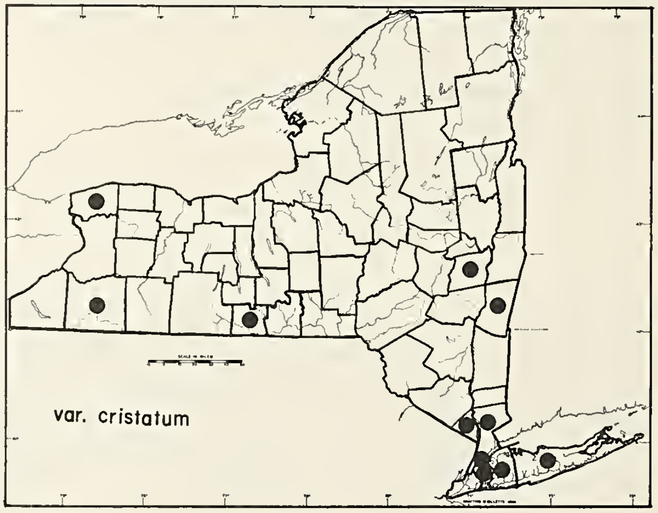
Description: Plants with bisexual flowers; **stigmas** 3, capitate, usually sessile; **styles** wanting or extremely short; **ovary** 1, becoming a 3-angled **achene;** achene sharply angled, dark brown to black, smooth, lustrous, variable in size, 2–6 mm. in length, 1–3 mm. wide, tapered at both ends; **stamens** 8, included; **perianth** 5-lobed to below the middle, with 3 winged and 2 unwinged lobes, varying greatly in size between varieties, 3.8–15.8 mm. long, 1.7–6.1 mm. wide at maturity; **wings** moderately to strongly expanded, extending nearly to the joint of the pedicel, entire or minutely lacerate, flat, undulate or crinkled in the small-flowered variety, greenish to creamy, tan or reddish; **pedicels** jointed near the flower base, 4–8 mm. long; **bracts** tubular, scarious-sheathing; **inflorescences** 1–28 cm. long, racemes or smaller fascicles borne in the axils of much-reduced leaves which are bract-like, but borne from sheathing **stipules;** leaves cordate to truncate-deltoid or even hastate, usually acuminate tipped, grading from dwarf inflorescence leaves, up to 14 cm. long and 7 cm. wide in the typical variety, papillose to minutely pubescent, paler below; **petioles** 0.5–10.2 cm. long, strongly reduced upward; **stipules** tubular-cylindric, 1–6 mm. long, truncate to acute, shattering with age, papillose; **nodes** scarcely swollen, eciliate; **internodes** furrowed, greenish to red-brown, elongate, slender; **stems** with twining tips, up to 3 m. long from a perennial **rootstock** (2n = 20, ca. 44).

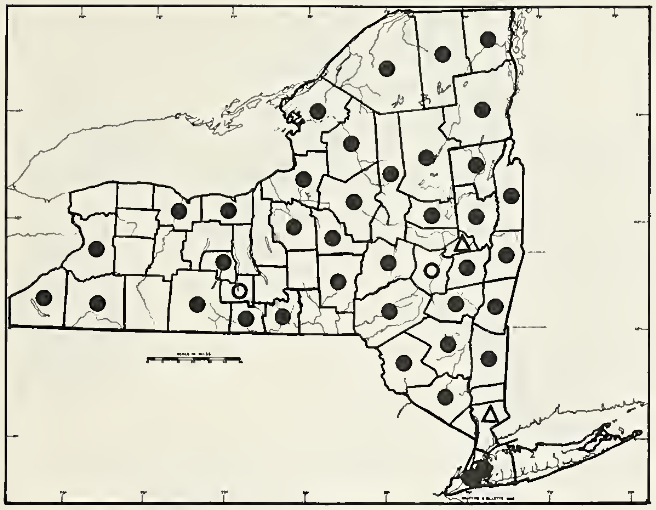
Infraspecific Variation: This species has been interpreted as having 3–5 varieties, 3 of which have also been recognized as species by some authors (Small, 1892; Fernald, 1950). Achene and perianth size vary extremely from one population to another, and do not necessarily seem to be correlated on a one-to-one basis. Although the entities intergrade and overlap, there is little doubt that there are robust and depauperate phases, and that one component is introduced from Europe (var. *dumetorum*). The group is in need of careful, statistical study.

KEY TO VARIETIES

1. Perianth weakly winged, especially at apex, 7–9 mm. long (measured from joint), wings often undulated-crinkled, greenish to cream; achenes 2.1–2.7 mm. long at maturity...*P. scandens* L. var. *cristatum* (Engelm. and Gray) Gleason
1. Perianth strongly winged, especially at apex, 7–15 mm. long, wings flat or weakly undulate, brownish-green to reddish; achenes 3–6 mm. long..(2)
    2. Perianths mostly 9–10 mm. long; lower leaves truncate to cordate, usually 3–4 cm. long, gradually reduced upward.. *P. scandens* L. var. *dumetorum* (L.) Gleason
    2. Perianths mostly 10–15 mm. long; lower leaves 4–12 cm. long, rounded-cordate, strongly reduced upward...*P. scandens* L. var. *scandens*







6. *Polygonum cilinode* Michx.

Common Names: Fringed Bindweed, False Buckwheat

Type Description: Michaux, Fl. Bor. Amer., 1:241, 1803

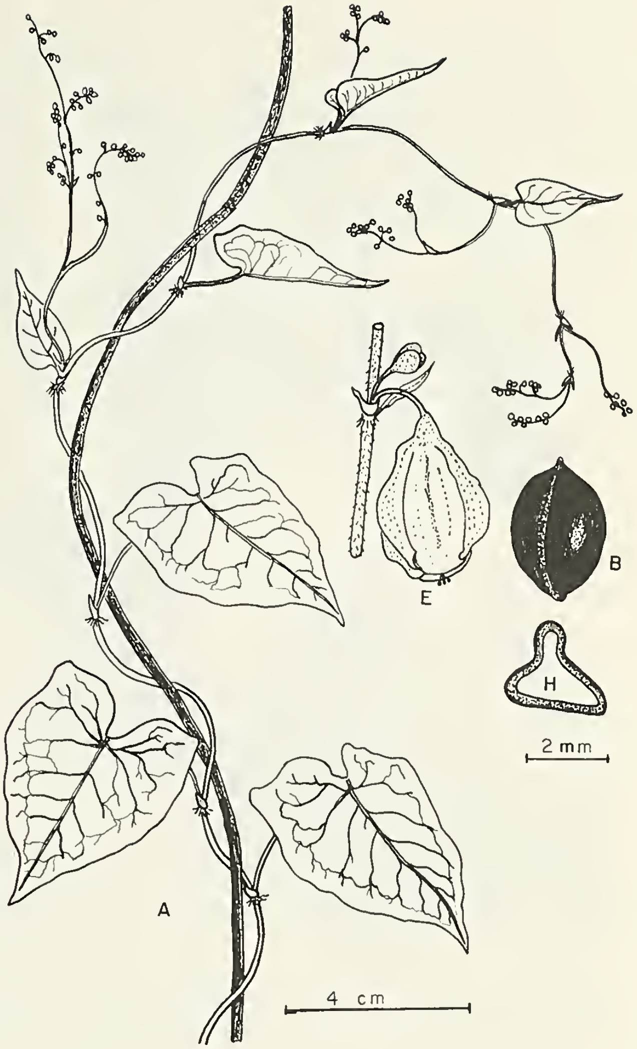
Origin: Northeastern North America

Habitats: Woodland borders, dry thickets, rocky slopes and disturbed sites

Habit: Climbing and twining (rarely erect)

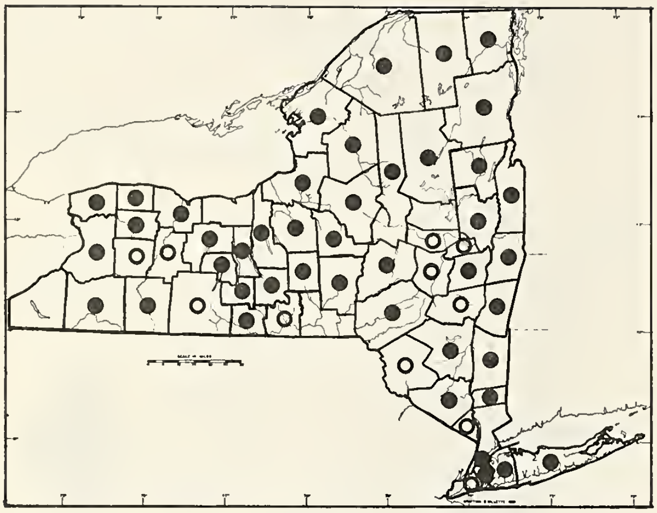
Flowering: July–October

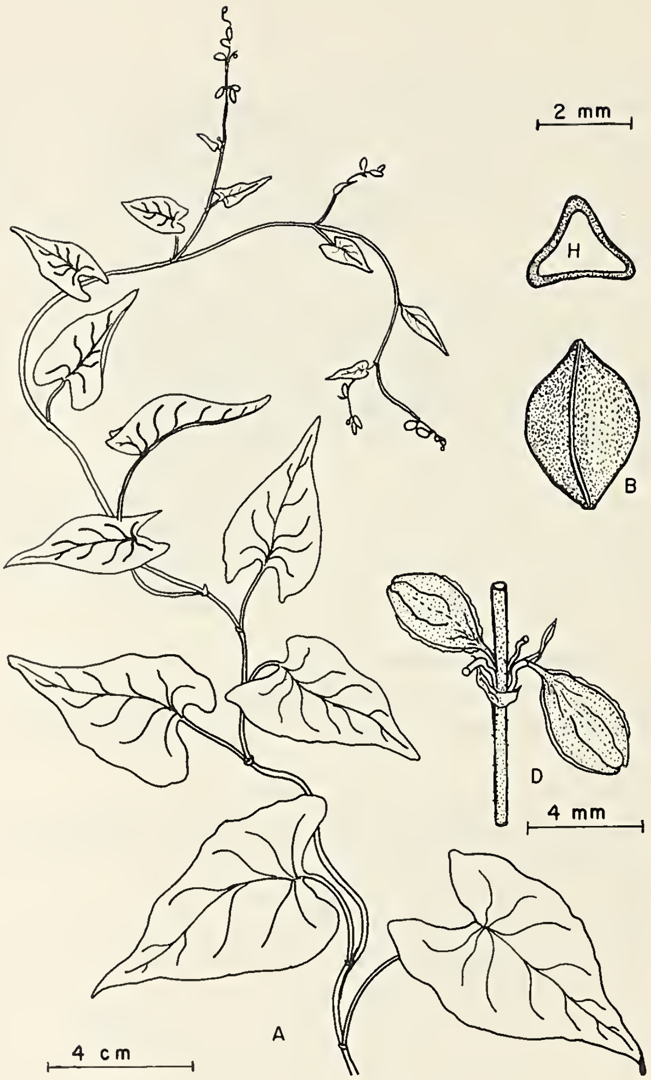
General Distribution: Nova Scotia to North Carolina and west to Minnesota



Description: Plants with bisexual flowers; **stigmas** 3, capitate; **styles** 3, less than 0.5 mm. long; **ovary** 1, becoming a 3-angled **achene;** achene 3–4 mm. long, lustrous, smooth, brownish-black, included or slightly exserted; **stamens** 6–8, included; **perianth** 5-lobed to below the middle, obscurely keeled, 3–4 mm. long, greenish-cream to white margined; **pedicels** wiry, somewhat reflexed, 3–4 mm. long; **bracts** sheathing, 1–2 mm. long, green to red-tinged; **inflorescences** slender, elongate, interrupted panicles of small fascicles and both terminal and axillary racemes, up to 15 cm. long; **peduncles** reddish-puberulent; **leaves** cordate-ovate, with irregularities and some sharp angles, pilose-hispid, strongly veined and becoming reddish beneath, 2–6 (12) cm. long, 2–5 (10) cm. wide, drastically reduced upward; **petioles** up to 6 cm. long, pilose-hispid; **stipules** sheathing, oblique, scarious, reddish, glabrous or puberulent; **nodes** with a fringe of reflexed hairs and slender bristles at the base of the stipule; **internodes** slender, terete, reddish, pilose-hispid; **stems** twining or sprawling (rarely erect) up to 5 m. long, from a perennial **rootstock** ($2n = 40$).

Infraspecific Variation: Plants of rocky or sandy areas may stand erect or ascend from a prostrate stem in forma *erectum* (Peck) Fern. Nearly glabrous populations are known from Virginia and West Virginia.





7. ***Polygonum convolvulus* L.**

Common Names: Black Bindweed, Cornbind, Ivy Bindweed, Nimble Will

Type Description: Linnaeus, Species Pl., p. 364, 1753

Synonym: *Bilderdykia convolvulus* (L.) Dum.

Origin: Europe

Habitats: Cultivated fields, waste places, roadsides, railroad tracks, etc.

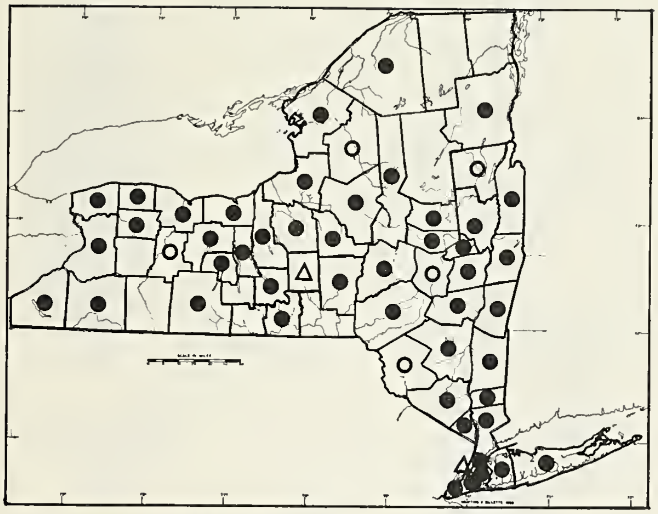
Habit: Trailing or climbing annual vine (depauperate specimens may be erect)

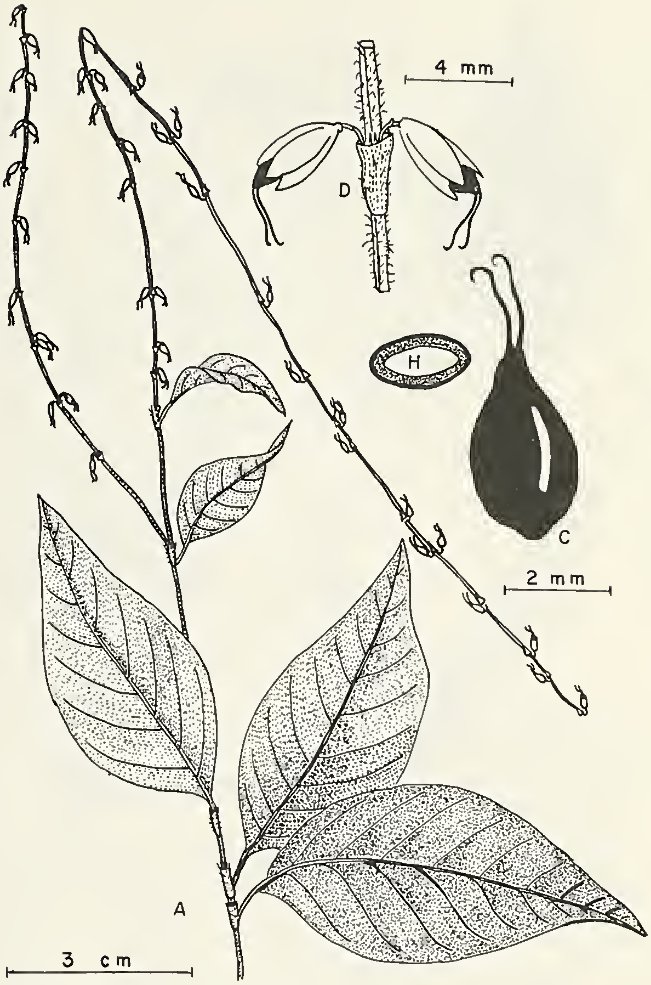
Flowering: May–October

General Distribution: Middle latitudes of the Northern Hemisphere

Description: Plants with bisexual flowers; **stigmas** 3, capitate, approximate; **styles** 3, very short, united just below stigmas; **ovary** 1, becoming a 3-angled **achene;** achene 3–4 mm. long, tightly enclosed, by the accrescent perianth, ovoid-acute at the tip and base, black, minutely granular-tuberculate, dull to somewhat shiny; **stamens** 8, included; **perianth** divided from below middle into 5 lobes, greenish-white or purple-blotched, 3.5–5 mm. long at maturity, outer lobes obscurely keeled and often beset by short, blunt, hyaline hairs; **pedicels** shorter than perianth, jointed above the middle; **bracts** pellucid, scale-like, largely concealed by stipules; **inflorescences** of 3–6 flowered fascicles, widely spaced below, axillary or appearing as terminal racemes due to leaf reduction and shortened internodes near the apex; **leaves** ovate-cordate to triangular-sagittate, up to 6 cm. long, 5 cm. wide, glabrous or with blunt, flat hairs on margins and veins; **petioles** slender, up to 5 cm. long, with rows of short hairs; a **nectariferous gland** at the base of the petiole; **stipules** sheathing, oblique, 2–4 mm. long, truncate, reddish-brown, margin entire, only lacerate with age, surface with small transparent hairs; **nodes** scarcely swollen, eciliate; **internodes** slender, wiry, reddish, grooved with small, reflexed, hyaline hairs; **stems** branched, twining (rarely erect) usually climbing on other plants, up to 5 m. long, arising from a wiry **taproot** (2n = 20, 40).

Importance: This is a particularly noxious and aggressive weed of crop fields; a yellow (musk colored) dye has been extracted from the whole plant; primitive man in Europe ground the seeds finely for flour. It is not a desirable food source due to low starch and highly abrasive achene fragments.





8. ***Polygonum virginianum* L.**

Common Name: Jumpseed

Type Description: Linnaeus, Species Pl., p. 360, 1753

Synonym: *Tovara virginiana* (L.) Raf.

Origin: Eastern North America (Arctotertiary element with relatives in Asia)

Habitats: Rich woodlands, moist soils of streambeds and lake margins

Habit: Spreading to erect perennial

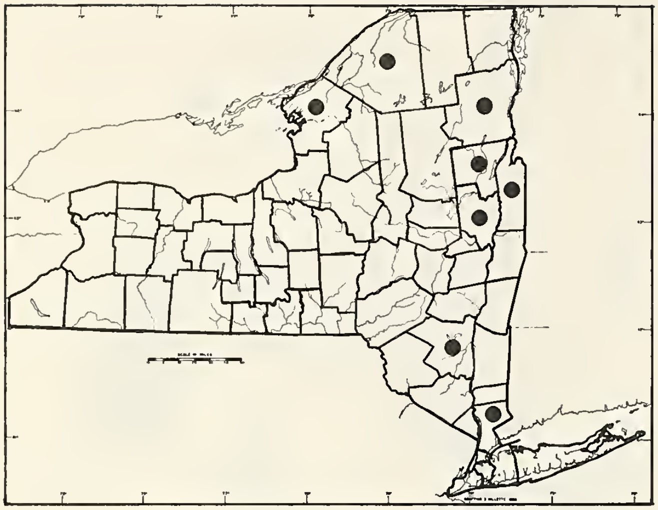
Flowering: July–October

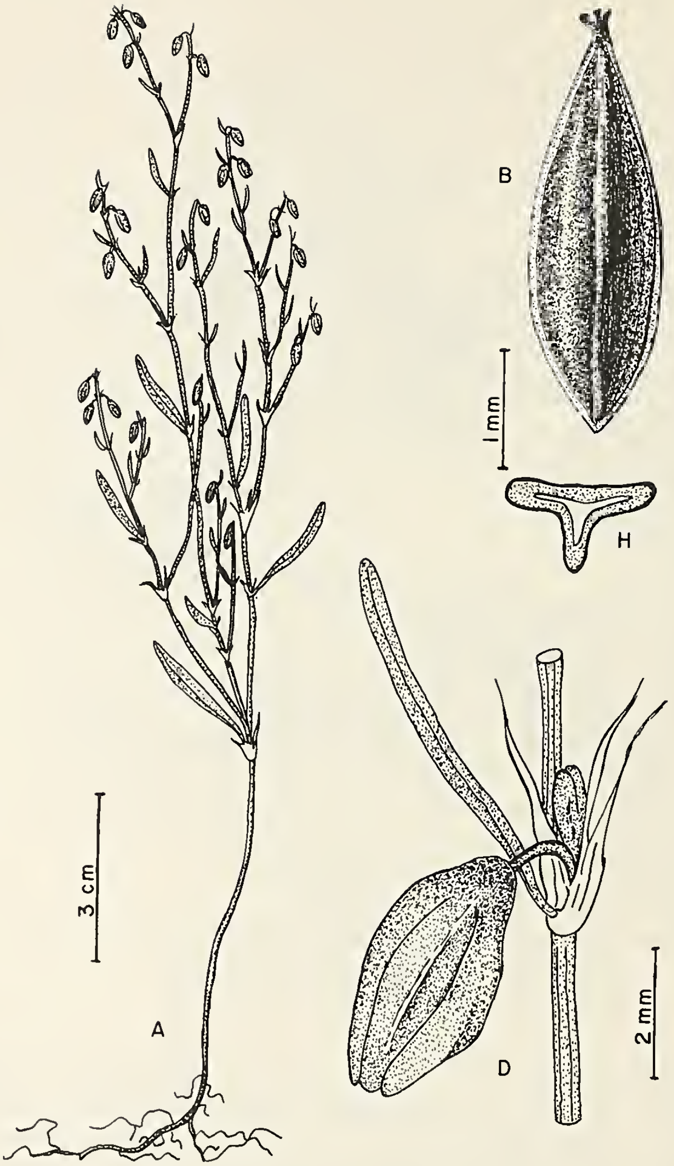
General Distribution: Eastern United States and Canada, south to Florida and Texas (Asia)

Description: Plants with bisexual flowers; **stigmas** 2, minute; **styles** 2, separate to the bases, rigid, resilient, deflexed and hooked at the tips, 2–4 mm. long; **ovary** 1, becoming a brown, lens-shaped **achene;** achene 3.4–4 mm. long, ovoid-oblong, enclosed or weakly exserted; **stamens** 5, about the length of the perianth; **perianth** 4-lobed to about the middle, greenish-white (rarely pink), 3.6–4 mm. long; **pedicels** jointed at the perianth base, about 3 mm. long, often deflexed; **bracts** sheathing-ciliate, overlapping near the inflorescence tip, but remote lower down; **inflorescences** 1-several, much-interrupted, narrow, elongate panicles of fascicles, 2–3 flowers per bract, the terminal inflorescence up to 50 cm. long; **peduncles** pubescent; **leaves** ovate to elliptic-lanceolate, 3–16 cm. long, 1.5–7 cm. wide, scabrous to strigose-pilose, especially beneath (rarely almost glabrous); **petioles** 1–20 mm. long; **stipules** tubular-cylindric, strigose, with bristles on the margins; **nodes** scarcely swollen; **internodes** often elongate, pubescent; **stems** lax to erect, up to 1.5 meters tall, from a knotty to slender **rhizome** (2n = 44).

Infraspecific Variation: Plants with reddish flowers have been called forma *rubra* Moldenke; plants with thin, almost glabrous leaves and slender rhizomes (possibly shade adaptations) have been called var. *glaberrima* Fern.

Note: The name Jumpseed comes from the properties of the indurate styles which have a spring-like resilience, and may project the achene up to 3 meters if properly snagged.





9. ***Polygonum douglasii*** **Greene**

Common Name: Knotweed

Type Description: Greene, Bull. Calif. Acad. II, 1:125, 1885

Origin: Native, Western North America

Habitats: Dry soil or gravel, primarily in the mountains

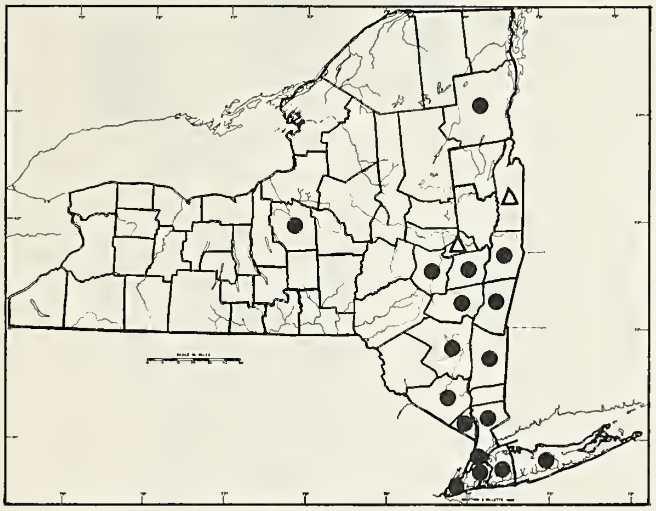
Habit: Erect, simple to branched annual

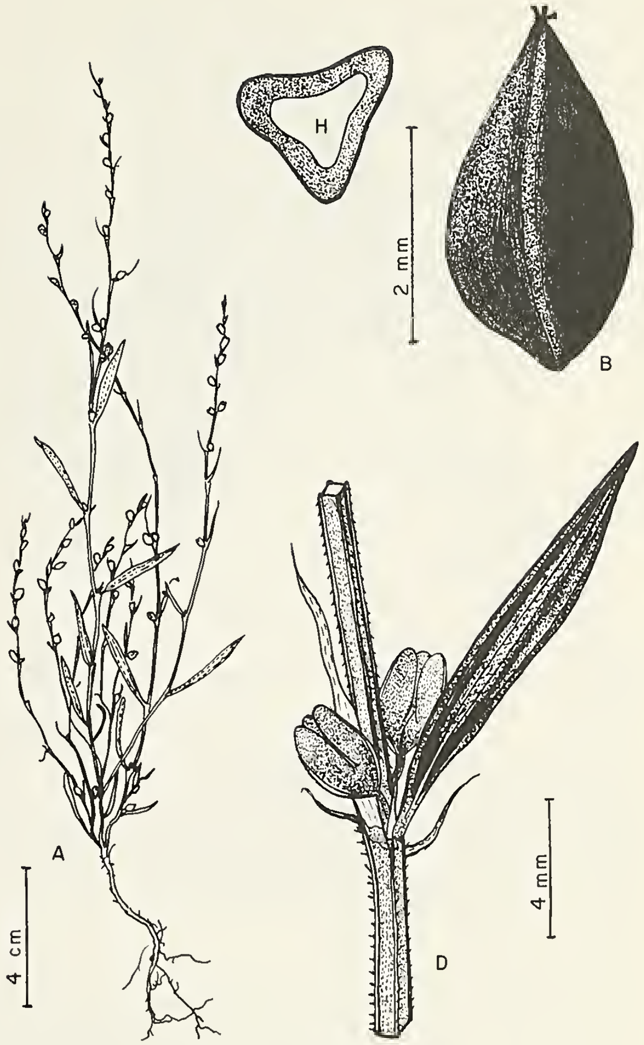
Flowering: June–September

General Distribution: Mostly Western North America, extending to the Northeast, but less common

Description: Plants with bisexual flowers; **stigmas** 3; **styles** 3, about 0.4 mm. long; **ovary** 1, becoming a trigonous **achene;** achene strongly 3-angled, lanceolate in outline, 3–3.5 mm. long; included in and exceeded by the perianth, (achene) with three concave sides, apex acuminate, also tapered below to a slightly stipitate base, surface black, smooth and lustrous; **stamens** usually 8, the inner dilated at the base the outer adnate to the perianth and not exceeding it; **perianth** 4–6 mm. long, divided from near the base into 5 petaloid lobes, tannish to green with white or roseate margins and cucullate tips; **bracts** pellucid, sheathing, interior to the stipules and scarcely discernible; **inflorescences** 2–4 flowered fascicles scattered on the erect branches, flowers more common toward the branch tips, reflexed on 1–4 mm. long **pedicels; leaves** linear or narrowly oblong to lanceolate, reduced in size toward the apex of the plant, 15–40 mm. long, 2–8 mm. wide, margins sometimes revolute; **petiole** short or absent with the leaf jointed directly to the stem; **stipules** 5–12 mm. long, hyaline, sheathing, lacerate; **nodes** slightly swollen; **stems** striate, often 4-angled above the base, simple to freely branching, erect, 10–75 cm. tall, arising from a slender, wiry; **taproot** (2n = 40).

Infraspecific Variation: Most of the variation in this widespread species occurs in the Western States where it is more common and has alpine varieties.

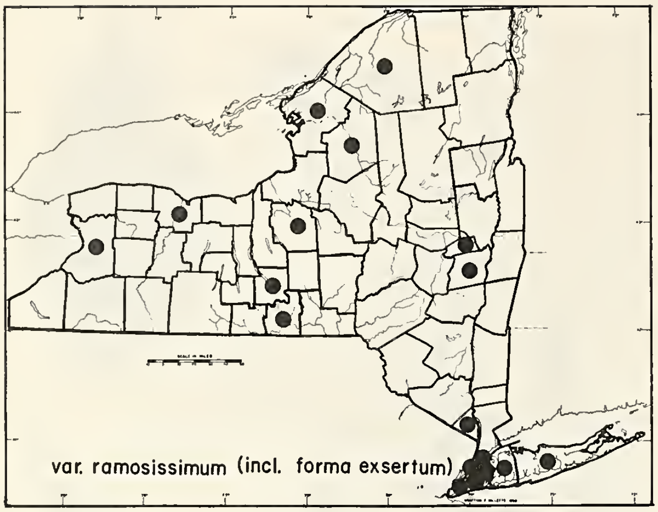




10. Polygonum tenue Michx.

Common Name: Knotweed
Type Description: Michaux, Fl. Bor. Amer., I:238, 1803
Origin: North America
Habitats: Dry, open, sunny situations, shale hillsides
Habit: Erect, slender, wiry annual
Flowering: June–October
General Distribution: Eastern Canada to Minnesota, south to Georgia and west to New Mexico

Description: Plants with bisexual flowers; **stigmas** 3; **styles** 3, 0.3–0.4 mm. long; **ovary** 1, becoming a sharply trigonous **achene**; achene ovoid, tightly enclosed by the perianth, (achene) 2.5–4 mm. long with 3 concave sides, apex acute, lower half tapering to a somewhat stipitate base, surface black or dark brown, smooth or faintly striate at the angles or apex; **stamens** usually 8: filaments of inner stamens dilated at the base, outer ones adnate to the perianth lobes; **perianth** 2.6–4.2 mm. long, divided from near the base into 5 petaloid lobes, brownish to green with white or roseate margins, inner lobes shorter than the outer ones, which are cucullate; **inflorescence** an elongate, slender, interrupted spiciform raceme; **flowers** disposed singly or in 2–3 sparsely flowered fascicles; flowers erect on **pedicels**, 1–1.5 mm. long; **bracts** hyaline, sheathing within the stipules which are similar; **leaves** narrowly lanceolate to linear, firm, ascending, 5–40 mm. long 1–8 mm. wide, with 2 deep pleats parallel to the midrib axis, apex acute or cuspidate, base acute, margins slightly toothed and sometimes revolute; **stipules** hyaline, sheathing, lacerate, 3–15 mm. long; **nodes** slightly swollen, scabrous; **stems** 4-angled above the base, ridged, wiry, simple or branched, strongly ascending, arising from a slender annual **root** (2n = 20, 30, 32).



11. Polygonum ramosissimum Michx.

Common Name: Knotweed

Type Description: Michaux, Fl. Bor. Amer., I:236, 1803

Synonyms: *P. prolificum* (Small) Rob., *P. exsertum* Small, *P. atlanticum* (Rob.) Bickn.

Origin: Native of North America

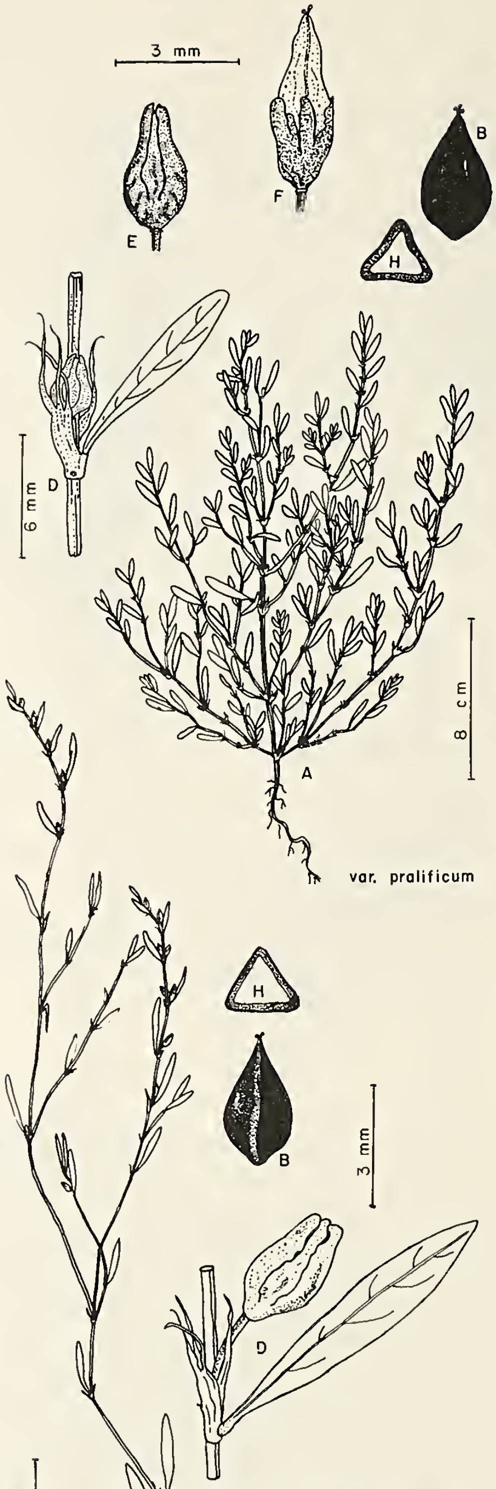
Habitats: Salt marshes, sandy soils, lake shores, riverbeds and waste places on occasion

Habit: Erect or ascending, much branched, occasionally procumbent-prostrate

Flowering: July–November

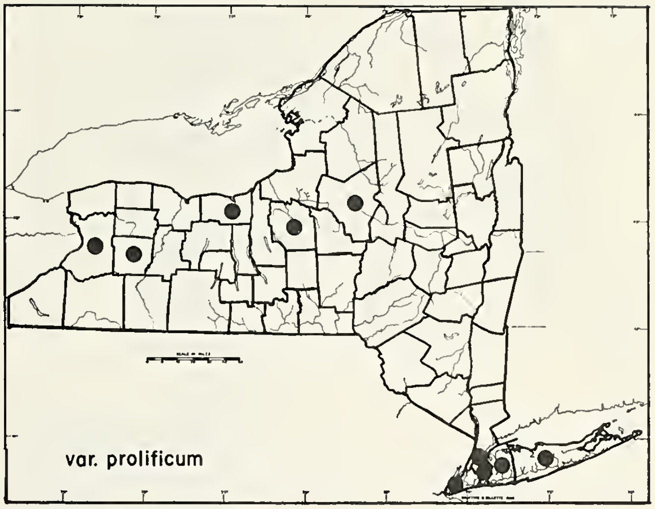
General Distribution: The typical variety is mostly Midwestern from Saskatchewan to New Mexico; salt marsh populations of the other variety and form range from Maine to Virginia

Description: Plants with bisexual flowers; **stigmas** 3; **styles** 3, united below, 1–5 mm. long; **ovary** 1, becoming a trigonous (or biconvex) **achene;** achenes often dimorphic (especially in late season): either ovoid, 3-angled, with 3 concave sides, 2–3.5 mm. long, brown with shiny surfaces, included in the perianth, or lens-shaped, inflated, lanceolate with 2 convex sides, 4–6.5 mm. long, pale yellow-brown to greenish, shiny, exserted from the perianth; **stamens** 3–6: inner filaments dilated, anthers yellowish, not exceeding the perianth; **perianth** 3–4 mm. long, divided from near the base into 5 (6) petaloid lobes, brownish green to yellow-green or with roseate margins, outer lobes, cucullate, inner ones short, flattened; base of fruiting perianth usually with slightly keeled or pouch-like protrusions; **bracts** sheathing, pellucid; **inflorescences** 2–4 flowered fascicles, weakly or strongly exserted from the stipules in the axils; **pedicels** angular or terete, 1–3.5 mm. long; **leaves** from bluish to yellow-green, sometimes glaucescent, prone to red fall coloration,



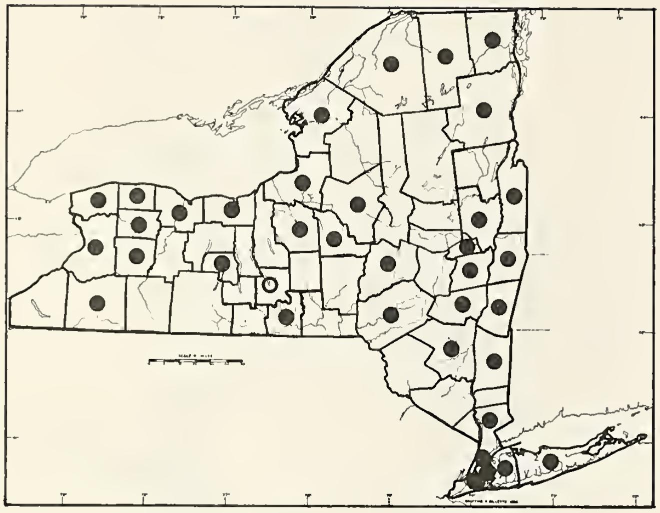
either heterophyllous with lanceolate leaves or approaching homophylly with oblanceolate leaves; **leaves** 0.7–6 cm. long, 1–8 mm. wide, tips acute to broadly rounded; **petiole** short, jointed to stipular sheath; **stipules** several parted to 2-cleft, sheathing, hyaline, or brownish, becoming lacerate; **nodes** slightly swollen; **stems** prominently ribbed, woody, erect-ascending (rarely prostrate) profusely branched with age, up to 2 m. tall, arising, from a stout **taproot** (2n = 20, 60).

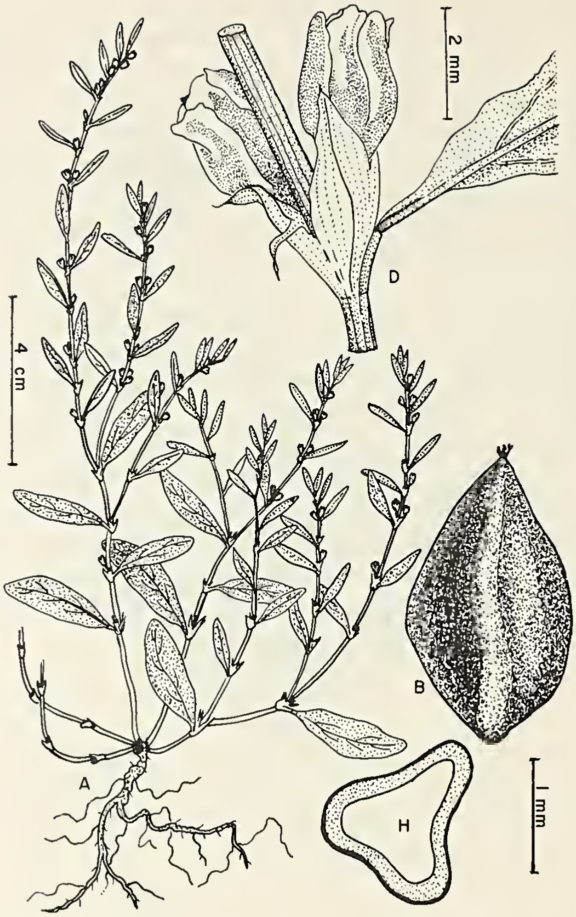
Infraspecific Variation: As recognized here, this is a species complex of considerable variability. The entities treated may be recognized as species upon further study, but specimens seen so far show too much integradation to be separated with satisfaction. The two reported ploidy levels suggest a search for a tetraploid level as well, and distribution patterns are also somewhat distinct. "*P. exsertum* Small" appears to be a salt marsh form in which there is a high percentage of exserted achenes. Judgments will be reserved until further reliable characters are found.



KEY TO VARIETIES

1. Plants strongly heterophyllous, leaf tips of the larger leaves obtuse to acuminate; pedicels 2.5–3.5 mm. long .... *P. ramosissimum* L. var. *ramosissimum*
1. Plants approaching homophylly, leaf tips rounded or slightly obtuse; pedicels less than 2 mm. long........ .... *P. ramosissimum* L. var. *prolificum* Small





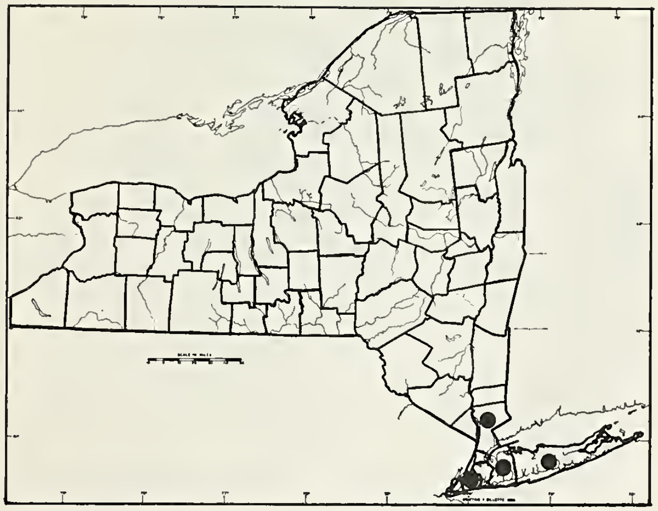
12. Polygonum aviculare **L.**

Common Names: Knotweed, Knotgrass
Type Description: Linnaeus, Species Pl., p. 362, 1753
Synonyms: *P. heterophyllum* Lindm., *P. monspeliense* Tieb.
Origin: Eurasia
Habitats: Disturbed and cultivated soils, roadsides
Habit: Much branched, erect to sprawling-decumbent
Flowering: June–November
General Distribution: Cosmopolitan weed

Description: Plants with bisexual flowers; **stigmas** 3; **styles** 3, short; **ovary** 1, becoming a trigonous **achene;** achene 2.5–3.2 mm. long, commonly included in the persistent **perianth,** (achene) with 2–3 ovoid-concave sides, apex acute, base somewhat stipitate, surface brown, punctate and striate, lusterless; **stamens** 8 (5–6): filaments dilated at the base, anther sacs yellow, not exceeding the perianth; **perianth** about 2.5–3.1 mm. long, divided to below the middle into 5 petaloid lobes . . .3 outer, 2 inner; outer lobes incurved, the inner flat; **lobes** obtuse with a greenish midrib and white, cream or roseate margins; **flowers** connate-turbinate below; **bracts** pellucid, often enveloping the flower bases; **inflorescences** usually 3–6 flowered fascicles, barely exserted from sheathing stipules in the leaf axils; plants **heterophyllous; leaves** gray-green, lanceolate to ovate-lanceolate; early stem leaves 25–60 mm. long, 4–15 mm. wide; later leaves much reduced, about ⅓ that size; leaves on short, jointed **petioles,** deciduous in late season (especially the larger ones); **stipules** 4–8 mm. long, hyaline, becoming lacerated; **nodes** slightly swollen; **stems** terete or somewhat grooved, freely branching, sprawling to erect, up to 2 m. long; arising from a wiry **taproot** (2n = 60, 40?).

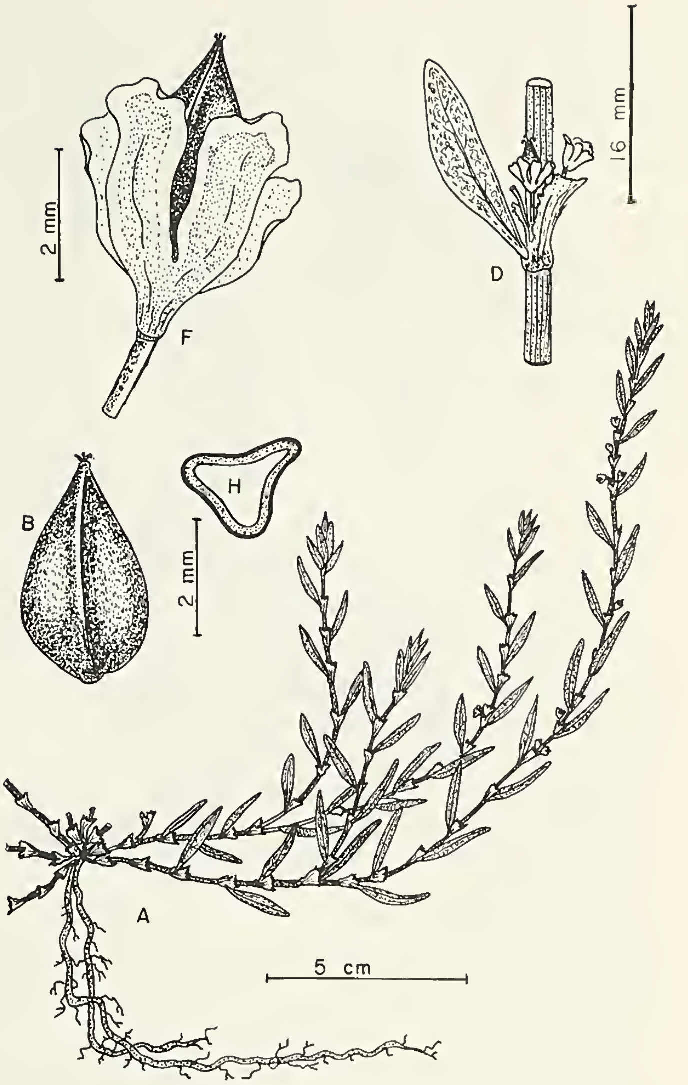
Infraspecific Variability: This species has had a variety of interpretations, and a large number of entities have been named as infraspecific categories under this binomial. It has long been confused with homophyllous *P. arenastrum* Bor., which once held varietal status under it. As recognized here (*sensu* Styles, 1962), it is the decidedly heterophyllous weed which shows variation mostly in habit, crinkling of the leaf margin and relative crowding of the inflorescences near the branch tips; flowers vary in size and color, and achenes vary in size and number of concave sides (all of this sometimes on the same plant). None of the above variations appear to warrant assignment of trinomials at present.

Importance: It is a weed of cultivated fields and waste places; achenes and young shoots are eaten by birds (hence its specific name) and stock graze on it; parched achenes have been used as food; in the lore of Shakespeare's time it was said to stimulate the appetites of swine and retard the growth of children if eaten raw; an infusion of uncooked materials is said to have diuretic properties, and has been used to treat internal bleeding, kidney disease and to expel stones; externally it has stiptic properties and has been used to treat sores and hemorrages such as nosebleed; African natives take it as an agent against malaria.



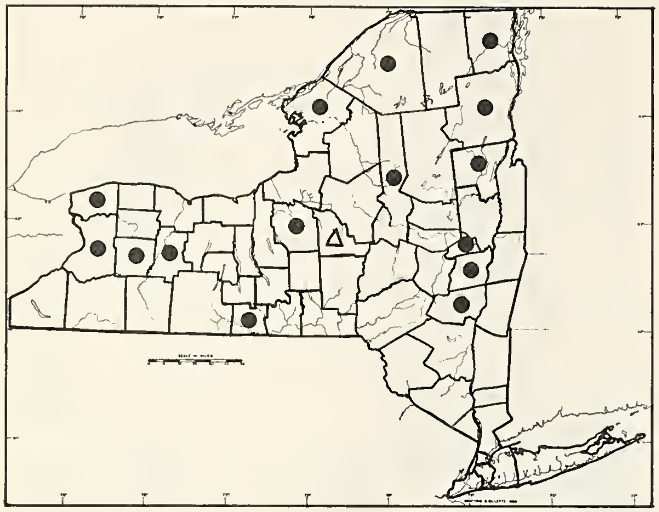
13. *Polygonum glaucum* Nutt.

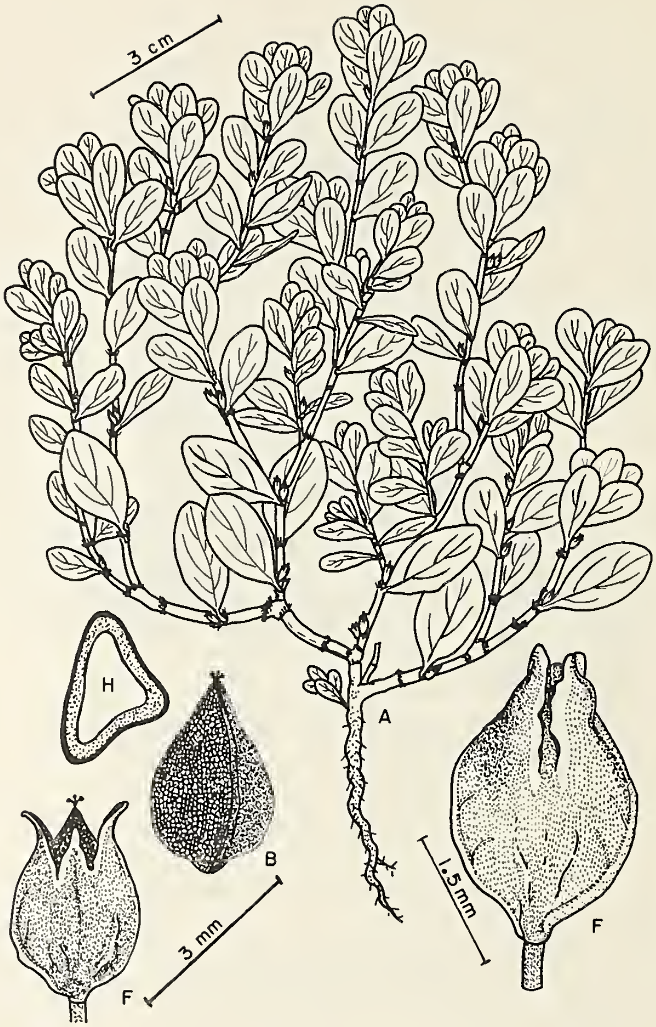
Common Names: Seaside or Seabeach Knotweed
Type Description: Nuttall, Gen., I:254, 1818
Origin: Native to North America
Habitats: Maritime sands, beaches, saline pond and marsh margins
Habit: Prostrate to ascending, wiry annual
Flowering: July–Number
General Distribution: East coastal zone of United States, Massachusetts to Georgia; inland in saline situations



Description: Plants with bisexual flowers; **stigmas** 3; **styles** 3, 0.4 mm. long; **ovary** 1, becoming a 3-angled **achene;** achene ovoid 3–4 mm. long, 2–2.5 mm. wide, exserted from the perianth, apex acute or acuminate, base somewhat stipitate, surface brown to blackish, lustrous; **stamens** 8: filaments dilated at the base, anther sacs yellow, not exceeding the perianth; **perianth** 3–4 mm. long, divided from near its greenish base into 5 lobes; **lobes** obovate, obtuse, spreading, with green midribs and white to pink margins; **bracts** pellucid, enclosing the flower bases; **inflorescences** axillary, 2–3 flowered; **pedicels** slender, erect, 3–4 mm. long; **leaves** gray-green, glaucous with rugulose surfaces, narrowly elliptic with acute to obtuse tips, margins revolute, leaves 5–30 mm. long, 2–8 mm. wide, **subequal; petioles** short, conspicuously jointed; **stipules** 3–15 mm. long, silvery white above, brownish below, persistent, with 8–16 nerves, 2-cleft, but finally shattering with age; **nodes** slightly swollen; **internodes** generally shorter than the leaves; **stems** terete, sulcate, generally prostrate, but with upcurving branch tips 20–70 cm. long, arising from a wiry **taproot** (2n = 40).

Note: This native species was confused in early reports with European *P. maritimum* L. and was reported incorrectly under that name in New York State.



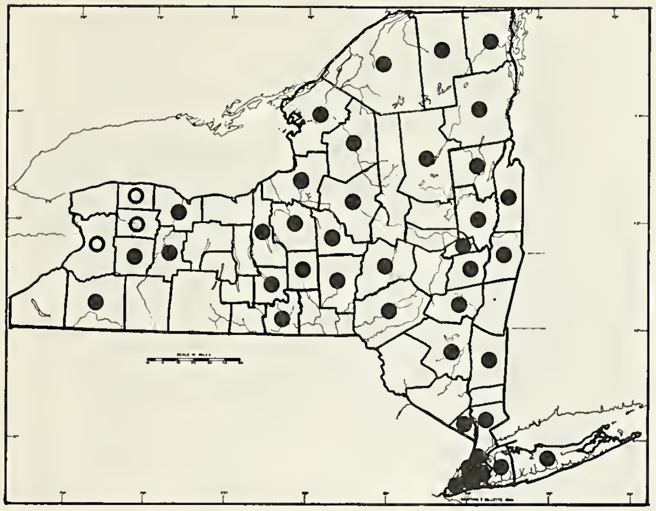


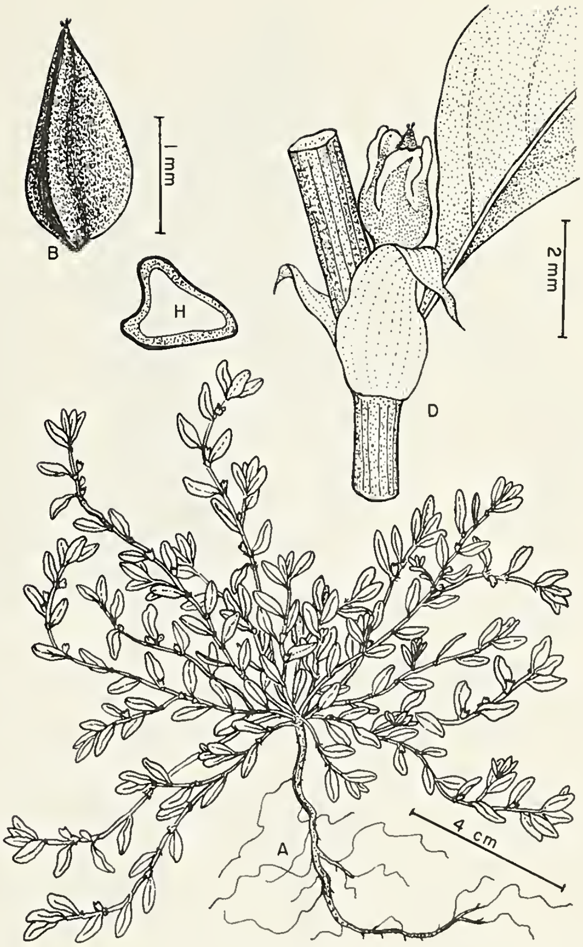
14. Polygonum achoreum **Blake**

Common Names: Knotweed, Homeless Knotweed
Type Description: Blake, Rhodora, 19:232, 1917
Origin: Uncertain, named from Vermont
Habitats: Dryish waste ground, disturbed soil, footpaths (saline marshes?)
Habit: Erect when young, spreading into mats with erect tips in age
Flowering: June–September
General Distribution: Weedy in boreal North America

Description: Plants with bisexual flowers; **stigmas** 3; **styles** 3, short; **ovary** 1, becoming a 3-angled **achene;** achene 2.5–3.5 mm. long, with 2 ovoid, concave and one narrower concave sides, apex acute, base minutely stipitate, surface yellow-brown to greenish, punctate-granular; **stamens** 3–8: filaments dilated at the base, anther sacs yellow, not exceeding the perianth; **perianth** 2.5–3.7 mm. long, constricted above the achene into a neck-like tip (this is sometimes spread by oversized achenes which become exserted in the late season); **perianth lobes** 5, the outer ones narrow, curved and strongly cucullate, often slightly keeled, the sinuses between lobes not extending to the middle of the perianth which is connate and broadly urn-shaped below; **flowers** are cream to green (or pink-tinged); **inflorescences** axillary, usually 1–3 flowered; **pedicels** 1–4 mm. long, erect, often concealed by the **stipules; leaves** bluish-green, numerous and crowded near the apex, **subequal** in size, oval to elliptic with rounded tips, 9–30 mm. long, 3–15 mm. in width; **petiole** short, jointed; **stipules** 5–11 mm. long, sheathing hyaline, 2-cleft, eventually shattering, **nodes** slightly swollen; **stems** terete, sulcate, erect when young, becoming prostrate with many upturned lateral branches (stems rarely up to 70 cm. long), arising from a woody **taproot** (2n = 20).

Infraspecific Variation: The species varies in habit, often being misidentified as *P. buxiforme* Small when sprawling and as *P. erectum* L. when upright. Color of perianth margins varies from cream to pinkish, and late-season achenes are elongate and become exserted, thereby changing the flower shape.





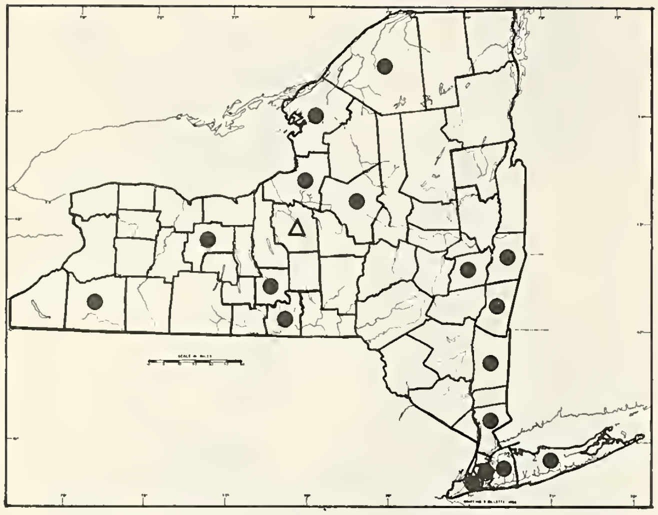
15. *Polygonum arenastrum* Boreau

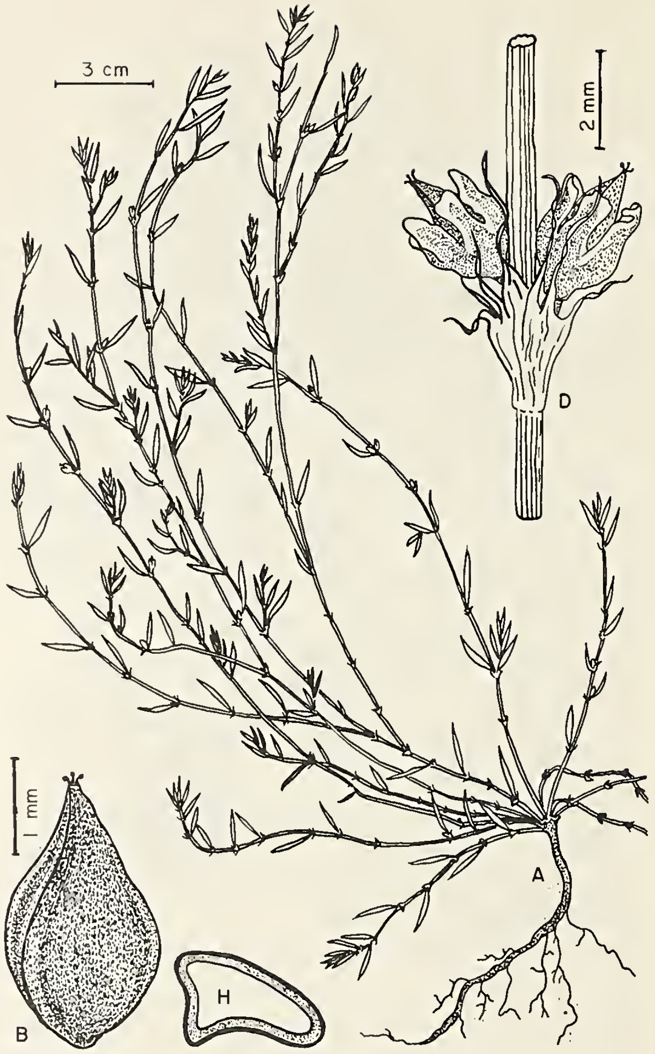
Common Names: Doorweed, Knotgrass
Type Description: Boreau, Fl. Centr. Fr., Ed. 3, 2:560, 1857
Synonyms: *P. aequale* Lindm., *P. aviculare* L. var. *arenastrum* (Bor.) Rouy
Origin: Eurasia
Habitats: Disturbed or packed soil and gravel, sidewalks, paths, roadways, etc.
Habit: Cespitose, mat-forming annual weed
Flowering: June–December
General Distribution: Cosmopolitan

Description: Plants with bisexual flowers; **stigmas** 3, **styles** 3, short; **ovary** 1, becoming a compressed, trigonous **achene;** achene 1.5–2.3 mm. long, included to exserted from the perianth, (achene) with two convex or flattish sides and one narrow, concave side (rarely biconvex), apex acute, base minutely stipitate, surface dark brown, lightly striate-punctate, occasionally somewhat lustrous at the edges; **stamens** generally 5 (8): filaments dilated at the base, anther sacs yellow, not exceeding the perianth; **perianth lobes** incurved or flared in fruit, obtuse to rounded, petaloid, greenish with white margins (often rose-tinted), equaling the achene length or slightly shorter; **perianth** divided to about the middle, connate below; **bracts** pellucid, sheathing; **stipular** sheaths hyaline, shattering; **inflorescences** axillary, usually 2–3 flowered, barely exserted from the sheath; **leaves subequal,** bluish-green, broadly elliptic to oval-oblong, rounded or bluntly obtuse at the tips, 5–20 mm. long, 3–9 mm. wide often deciduous in late season; **petiole** short, obscurely jointed; **stipules** 3–6 mm. long, 2-cleft, eventually lacerate; **nodes** slightly swollen; **stems** terete or lightly grooved, freely branching and mat-forming usually prostrate, arising from a wiry **taproot** (2n = 40).

Infraspecific Variability: Like *P. aviculare* L., with which it is often confused, this species varies in flower color and habit; flowers may produce elongate, pale achenes which protrude from the perianth in late season; although leaves are relatively uniform in size throughout the plant, they may grade in size with the season or under severely dry conditions, and the older ones may drop; shoot dimorphism may also occur if the substrate varies, such as when both dark soil and sidewalk are under different parts of the same plant; robust, ascending shoots have also been observed in moist, early winter.

Importance: This species is an extremely common weed in city streets and sidewalks, with amazing capabilities for survival; it is an accepted article in the international pharmaceutical market; however, its confusion with *P. aviculare* confounds the problem of identifying its specific properties; it is harvested in quantity in the U.S.S.R. for market; known variously in Europe as *Herba polygoni*, Homeriana Tea, *Herba sanguinariae* and Blutkraut, its medicinal properties are ascribed to tannins; the stiptic, anti-hemorrhagic properties are as in *P. aviculare*. It is also food for upland gamebirds and is used in some countries as fodder and birdseed.





16. Polygonum neglectum Besser

Common Name: Knotgrass

Type Description: Besser, Enum. Pl. Huc. Volh. etc., p. 45, 1822

Synonyms: *P. aviculare* var. *angustissimum* Meisn., *P. provinciale* Koch. (of N.Y. authors)

Origin: Introduced from Europe

Habitats: Disturbed, sandy ground of roadsides, pastures

Habit: Slender-stemmed, spreading, prostrate to ascending annual

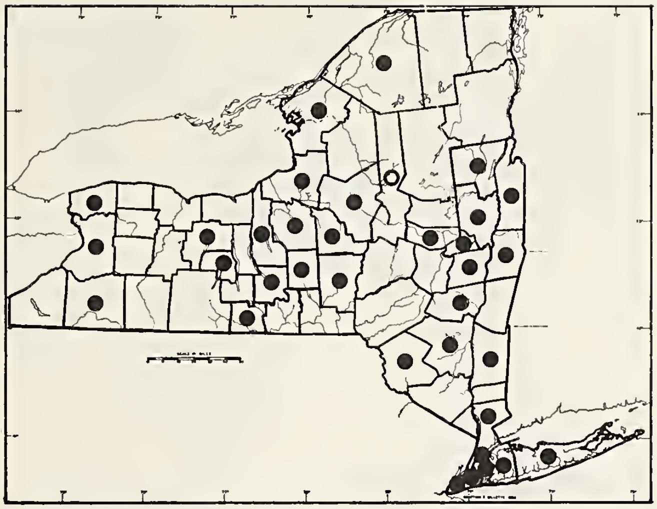
Flowering: May–October

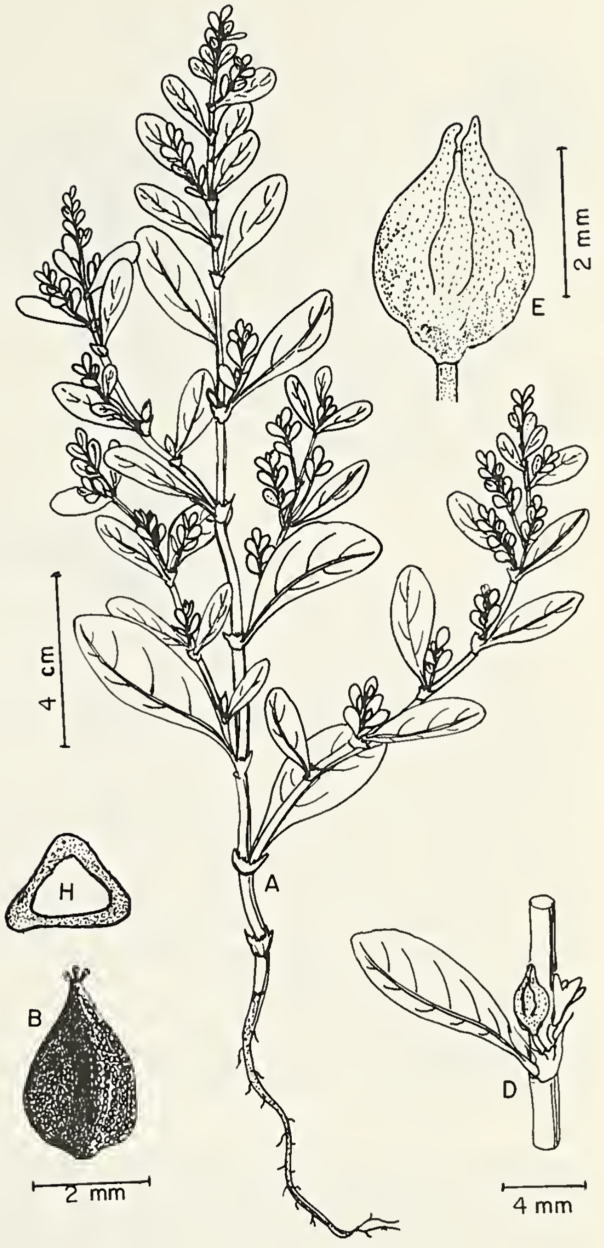
General Distribution: Eastern Europe and adjacent Asia; introduced in North America and Western Europe

Description: Plants with bisexual flowers; **stigmas** 3; **styles** 3, short; **ovary** 1, becoming a trigonous **achene;** achene 2.1–3 mm. long, often exserted from the persistent perianth, with 2–3 concave sides, apex acute, base somewhat stipitate, surface puncticulate, lusterless except the edges; **stamens** 8 (5–7): filaments dilated at the base, anther sacs yellow, not exceeding the perianth; **perianth** 2.0–3 mm. long, divided to or below the middle into 5 petaloid lobes; **lobes** narrow, obtuse to spathulate-rounded, often ascending and not overlapping in fruit, greenish white or usually roseate; **bracts** pellucid, enveloping the young flower; **inflorescences** 2–3 flowered fascicles, barely exserted from the sheathing stipules in leaf axils; **leaves subequal,** green to reddish (prone to fall coloration) acute, narrow, linear-oblong to linear-lanceolate, 8–30 mm. long; **petioles** very short, jointed; **stipules** prominent, hyaline, lacerate with age; **nodes** slightly swollen; **stems** slender, flexuous, terete, up to 30 cm. long, arising from a wiry **taproot** ($2n = 40$).

Infraspecific Variability: This species tends slightly toward heterophylly, making it doubtfully distinct from *P. aviculare;* however, the flowers are more like those of *P. arenastrum.* To complicate matters further, extreme flowers with roseate lobes and exserted achenes appear identical to those illustrated for *P. rurivagum* Jord., a heterophyllous species reported by Löve and Löve (1956) to be introduced into North America.

Importance: It is an insignificant weed with a few scattered locations in the State.





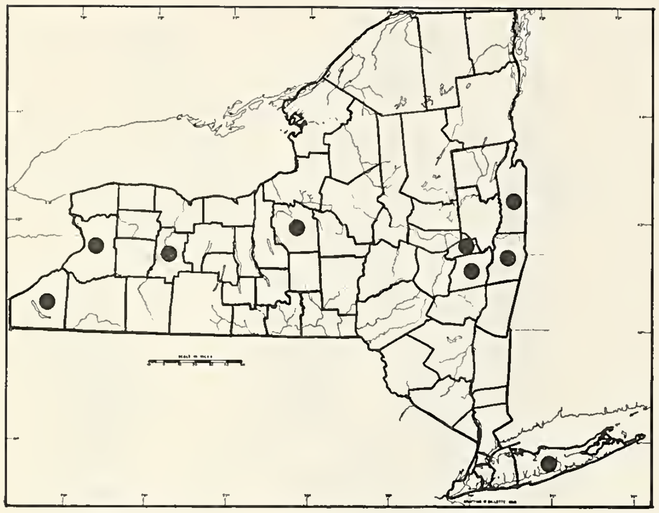
17. *Polygonum erectum* L.

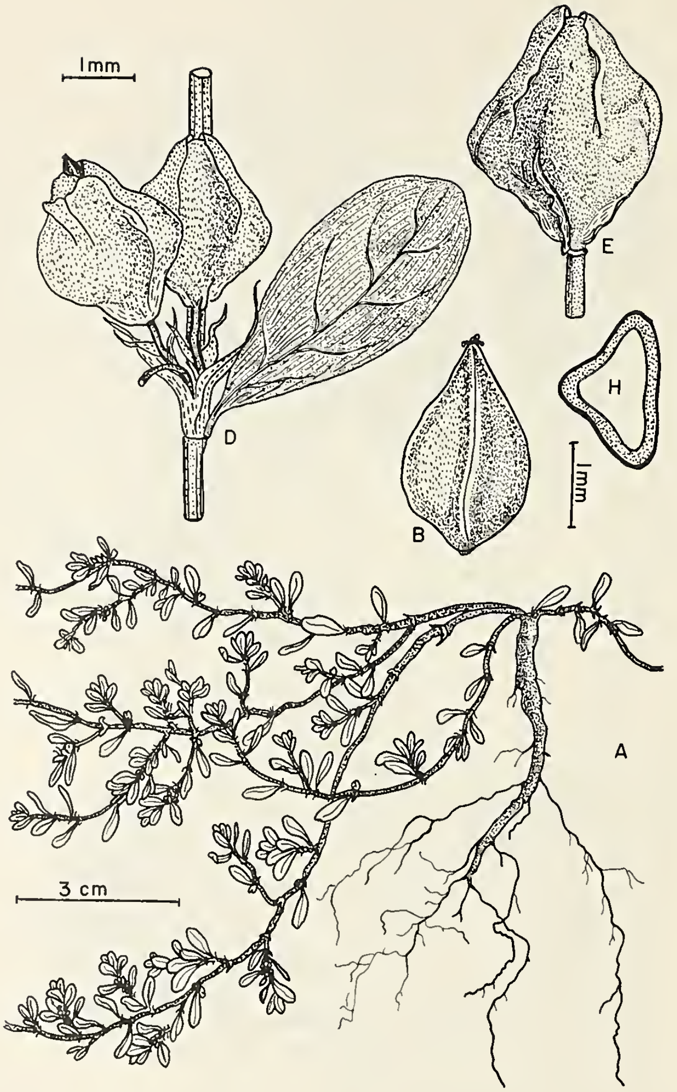
Common Names: Upright or Erect Knotweed
Type Description: Linnaeus, Species Pl., p. 363, 1753
Synonyms: *P. aviculare* var. *erectum* (L.) Roth, *P. aviculare* var. *laterale* Michx.
Origin: North America
Habitats: Waste ground, clearings, forest margins
Habit: Erect to spreading, branched annual
Flowering: June–September
General Distribution: Most of the United States and Southern Canada

Description: Plants with bisexual flowers; **stigmas** 3; **styles** 3, very short; **ovary** 1, becoming a trigonous **achene;** achene about 3 mm. long, enclosed in the persistent perianth, (achene) with 3 ovoid, concave sides, apex acute, base minutely stipitate, surface brown, striate-punctate; **stamens** 5–8: filaments dilated at the base, anther sacs yellow, not exceeding the perianth; **perianth** about 3–3.5 mm. long, parted to below the middle into 5 petaloid lobes; **outer lobes** cucullate and slightly keeled, inner ones narrow, flattened; **flowers** yellow-green; **bracts** pellucid, enveloping the flower bases; **inflorescences** axillary, 2–3 flowered; pedicels erect, exserted when mature; **leaves** green to bright yellow-green, elliptic to ovate with rounded to obtuse tips; plants becoming strongly **heterophyllous** with maturity, leaves of the main branches 2.5–6 cm. long, 1–3 cm. wide, much reduced on lateral branches; **petioles** short, jointed but seldom deciduous; **stipules** 5–10 mm. long, sheathing, becoming lacerate; **nodes** slightly swollen; **stems** terete, sulcate, erect or spreading, rarely up to .75 m. tall, arising from a wiry **taproot** (2n = 40).

Infraspecific Variation: Young plants with few flowers produce the larger leaf type in high proportion and may appear homophyllous at that stage; mature plants, however, are extremely heterophyllous.

Importance: As in other Knotweeds, it is reported for its astringent and stiptic properties when a decoction is made. It has also been used as a gargle and laxative.





18. Polygonum buxiforme Small

Common Name: Knotweed

Type Description: Small, Bull. Torrey Bot. Club, 33:56, 1906

Synonyms: *P. littorale* Link, *P. aviculare* var. *littorale* (Link) Koch, *P. aviculare* var. *crassifolium* Lange

Origin: North America

Habitats: Packed, nondrifting sands, dune and marsh borders and inland sandy soils

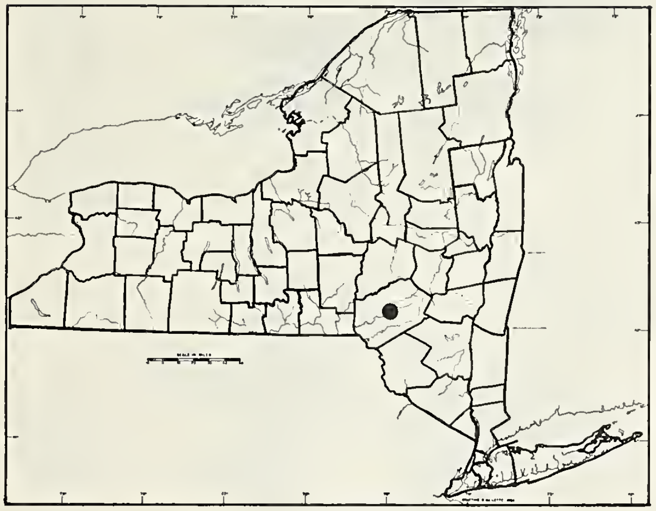
Habit: Generally a completely prostrate, much-branched, mat-forming plant

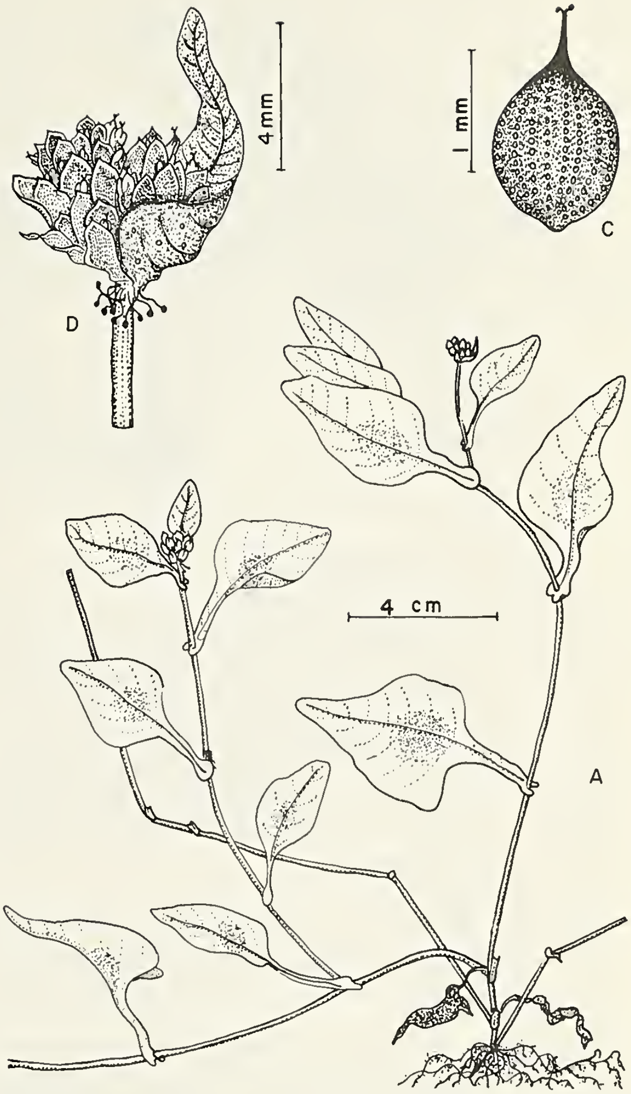
Flowering: June–October

General Distribution: Coastal and inland in the Eastern and Midwestern United States

Description: Plants with bisexual flowers; **stigmas** 3; **style** 3-cleft to near the base, .2 mm. long; **ovary** 1, becoming a trigonous **achene**; achene ovoid, 2–2.8 mm. long, 1.5–2 mm. wide, generally included in the fruiting perianth, usually with 2 concave and one broader, less concave side, apex acute, lower portion tapering somewhat to the slightly stipitate base, the surface light to dark brown, striate-punctate, shiny at the edges (or shiny surfaces and dull edges); **stamens** 8: inner filaments dilated, outer adnate to the perianth; **perianth** 2–3 mm. long, divided to below the middle into 5 petaloid lobes which are greenish with white to roseate margins, lobes cucullate, **lower perianth** asymmetric with a pouch-like protrusion, often with slight wings and protruding veins; **bracts** sheathing, pellucid to silvery, inside the stipules; **inflorescences** 2–6 flowered fascicles, barely exserted from the stipules in leaf axils; plants **homophyllous; leaves** bright to gray-green or glaucescent, oblong to oblanceolate, 3–20 mm. long, 1–8 mm. wide, apex obtuse or rounded, base tapering to a short petiole, margins often crinkled; **petioles** short, jointed; **stipules** 2-cleft, 4–5 mm. long, reddish-brown with hyaline extremities; **nodes** slightly swollen; **stems** prominently ridged, woody at the lower **internodes,** usually completely prostrate, branches up to 5 m. long, arising from a very stout, woody **taproot** (2n = 20, 60).

Note: This species has been confused with *P. aviculare*, but has the characteristic cucullate lobes of native American species. The chromosome counts and unusual coastal and disjunct inland distributions put its relationships clearly with the *P. ramosissimum* complex.





19. *Polygonum nepalense* Meisn.

Type Description: Meisner, Monogr. Pol. Prod., p. 84, 1826

Synonym: *P. alatum* Hamilton ex D. Don.

Origin: Nepal, central Asia

Habitats: Moist, wooded banks, streamsides

Habit: Ascending, annual herb

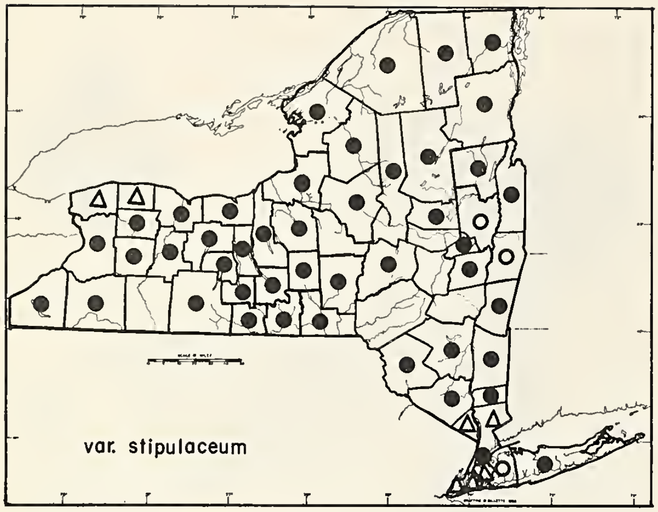
Flowering: July–October

General Distribution: Asian native, introduced in Russia, eastern Europe, Connecticut and the New York Catskills

Description: Plants with bisexual flowers; **stigmas** 2, capitate; **styles** 2, filiform; **ovary** 1, becoming a lens-shaped **achene;** achene red-brown with a finely reticulate surface of beady ridges, 1.5–2 mm. long, about 1 mm. wide, included in the persistent **perianth; stamens** 8, blackish purple; **perianth** about 2–2.2 mm. long, greenish-white to lavender or purple, 5-lobed; **pedicels** short; **bracts** greenish-white, equaling or exceeding the flowers in length; **inflorescences** capitate heads, usually with 8–30 flowers; **peduncle** with a tuft of glandular hairs at the base; **leaves** variable in size, 1–9 cm. long, ovate to deltoid with acuminate tips and truncated bases, but with the blades extending down the petioles as **wings** which clasp the stem; leaves pale green, red splotched, with tiny, yellow glandular dots; the winged **petioles** variable in length from 2–30 mm.; **stipules** scarious, associated with a tuft of hairs at the petiole base; **nodes** slightly swollen; **stems** laxly ascending from a tufted, annual **rootstock.**

Note: This species is reported from Connecticut (Fernald, 1950) and has now been found by Karl Brooks in three locations in the New York Catskills. It appears much like a native where it occurs.

Importance: The plants have been grown as a ground cover for shady yard areas and around gardens. The pale green leaves can be striking with their splash of red-purple.



20. *Polygonum amphibium* L.

Common Name: Water Smartweed

Type Description: Linnaeus, Species Pl., p. 361, 1753

Synonyms: *P. natans* Eat., *P. coccineum* Muhl., *P. fluitans* Eat., *P. hartwrightii* A. Gray, *P. inundatum* Raf., *P. muhlenbergii* S. Wats.

Origin: Uncertain, due to its almost cosmopolitan distribution; the center of diversity is in North America

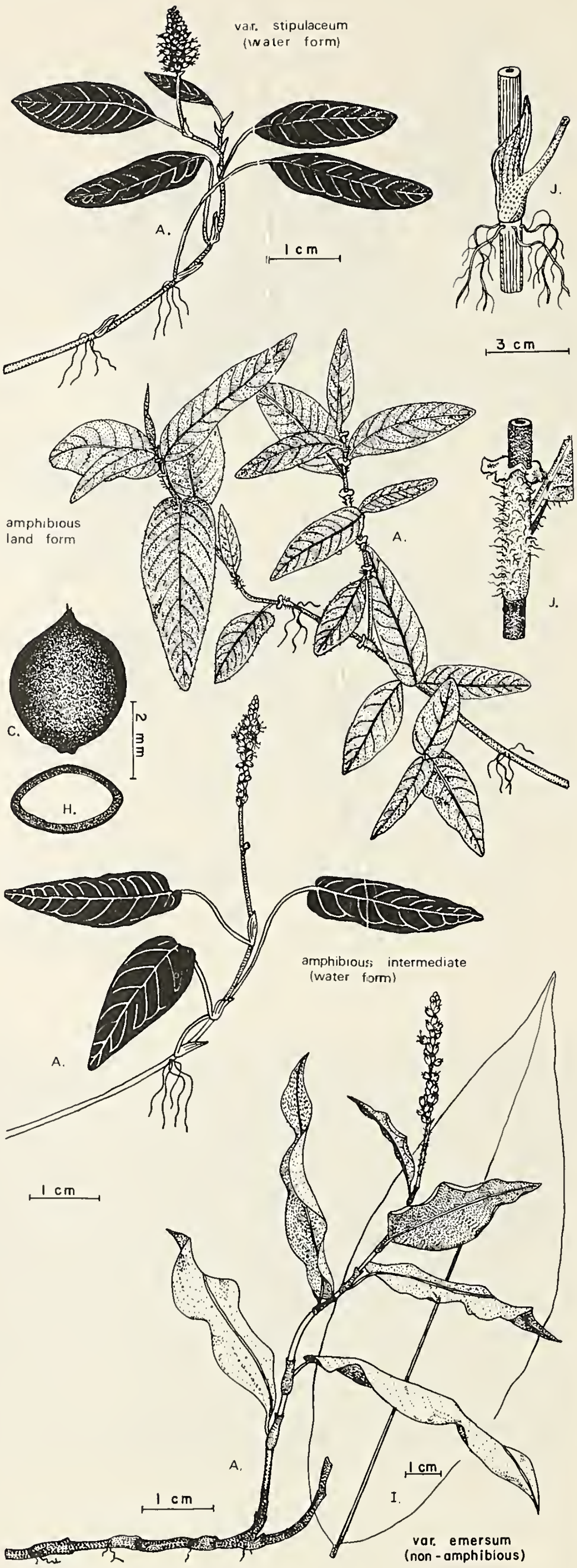
Habitats: A great number of aquatic situations, dry lakebeds and dunes

Habit: Amphibious or emergent, polymorphic species with three intergrading varieties and a number of land and water modification-types: floating, prostrate, ascending or erect . . . spreading by rhizomes and stolons

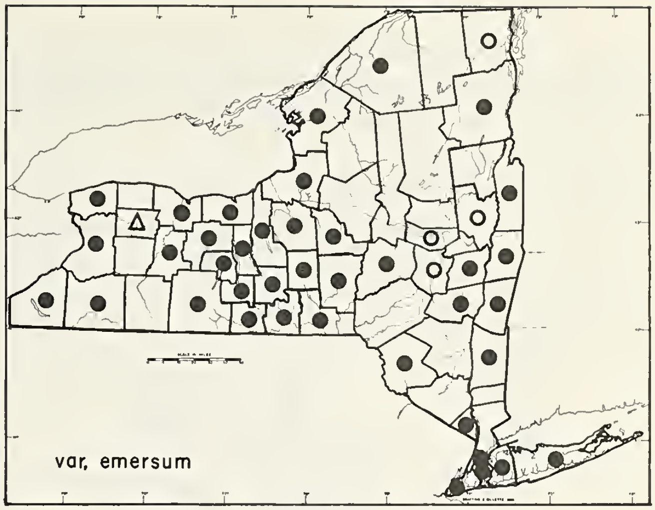
Flowering: June–October (New York)

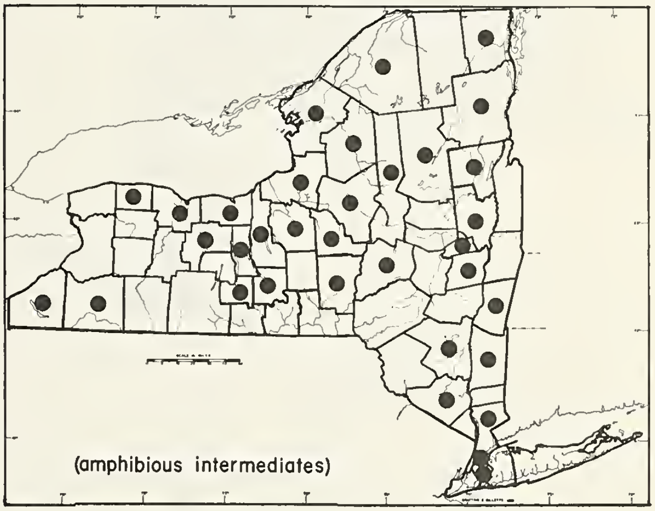
General Distribution: The typical variety is circumboreal and in South Africa; in North America it intergrades with two extreme varieties; all three occur in New York State along with intermediates

Description: Plants functionally dioecious (polygamous) with dimorphic flowers; **stigmas** 2, capitate; **styles** 2, united to near the summit, either 1–2 mm. long or 3–4 mm. long in flowers with short stamens; **ovary** 1, becoming a lens-shaped **achene**; achene ovoid-orbicular, highly glossy, dark brown to black, 2.5–3.2 mm. in diameter; **stamens** 8, either 4–6 mm. long, exserted, or 2–3 mm. long with collapsed anther sacs in flowers with long styles; **perianth** 4–5 mm. long with 5 bluntly rounded lobes, cut to below the middle, pink to rose or occasionally scarlet, enclosing the mature achene; **bracts** sheathing, scarious; **inflorescences** usually single or in pairs at the tips of major branches, stout, spike-like panicles, ranging from 1–2 cm. broad,



and from 2–15 cm. (18) long, depending on the variety; **peduncles** stout, grooved, variably glandular-pubescent to glabrous; **leaves** 3–35 cm. long, varying in shape and size with conditions; **floating leaves** glabrous, elliptic, with rounded tips to broadly cordate with acute tips, their petioles 10–80 mm. long; **subaerial leaves** elliptic oblong (obtuse tips) to lanceolate acuminate, their petioles 1–25 mm. long, pubescence ranging from scabrescent to pilose, from a mixture of simple and branched hairs of variable length; **stipules** 1–5 cm. long, varying with the habitat: **submerged stipules** obliquely sheathing, glabrous and opaque to silvery; **subaerial stipules** strongly tubular-sheathing, green when young and often developing a chlorophyllous collar or flange at the margin in early season; late-season stipules and those of the non-amphibious variety often lack these, turn brown and shatter; **stipule margins** may or may not have a fringe of bristles; **nodes** are often conspicuously swollen; **internodes** are extremely short in some terrestrial forms, but up to 30 cm. long in the stolons of mat-forming aquatics; **stems** are decumbent, floating, ascending or erect, depending on conditions, up to 2 m. in var. *emersum*, from slender to tough, woody **rhizomes** up to 2 cm. in diameter (2n = 96, 98).





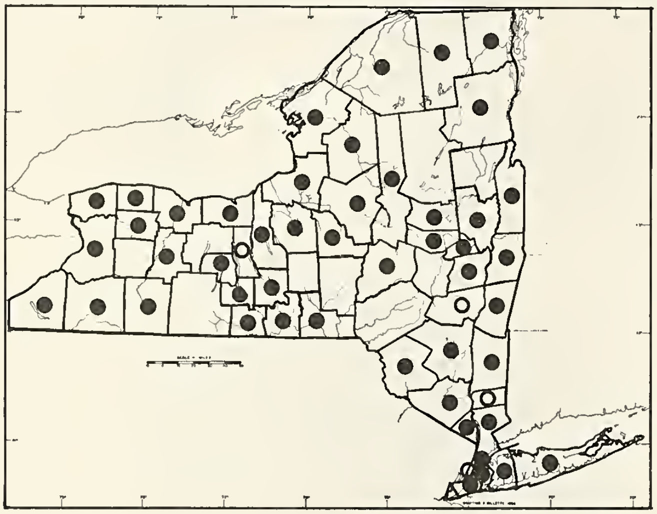
Infraspecific Variability: These aquatic plants assume so many postures and character-combinations that there has been considerable confusion and the application of over 100 species names. They appear to represent a cline of phenotypic variability from the most amphibious to the least (Mitchell, 1968, 1976). This corresponds to a morphological gradient with var. *stipulaceum* Colem. at one end, var. *emersum* Michx. at the other, and a broad range of intermediates, some of which are indistinguishable from Eurasian var. *amphibium*. The flared collar on the stipule of landforms is a seasonal character, found only in North American plants. This character alone keeps many amphibious intermediates from fitting the description of typical var. *amphibium*. Although no single character has been shown to distinguish the intergrading varieties, they are often quite different in appearance in the field. The following descriptions are offered for their separation, since a key is impractical:

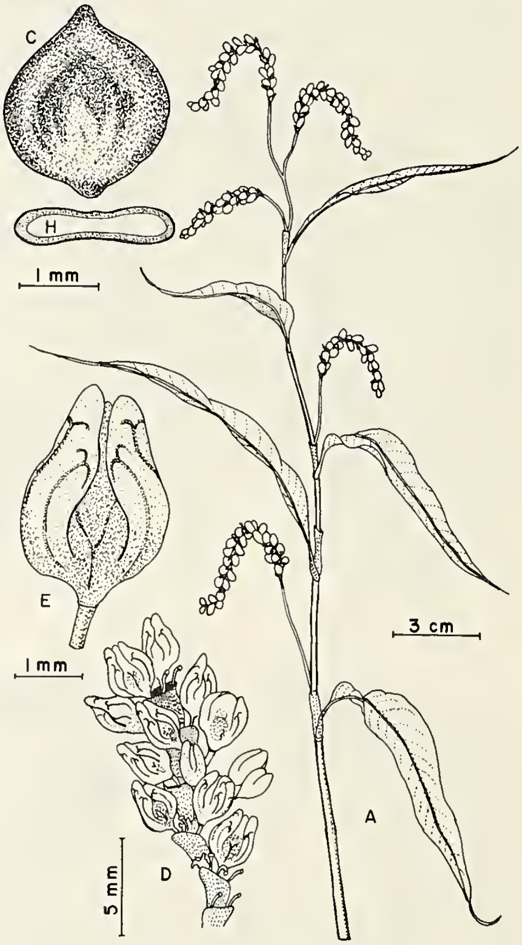
P. amphibium var. *stipulaceum* Colem. Typical plants flower in the water, not on land; inflorescences are 4 cm. long or less and leaves are glabrous, floating, elliptic; the landform is dwarfed, sprawling, quite pubescent, stipules flanged; the most highly adapted hydrophyte.

P. amphibium var. *emersum* Michx. Typical populations flower from strongly erect or emergent plants which are often quite robust; floating shoots and leaves are not produced; inflorescences are from 4–15 cm. long, and leaves are acuminate tipped, frequently with undulating margins; peduncles are glandular-pubescent in contrast to the former variety which only has this character occasionally when stranded away from water; stipules are not flanged with a collar, but turn brown at the margin and shatter; the most poorly adapted hydrophyte, but well adapted to temporarily moist situations: ditches, sloughs, rice fields as a weed.

P. amphibium, varietal intermediates (including var. *amphibium* in North America). Typical plants are amphibious, surviving and flowering almost equally well as floating, stoloniferous plants or ascending, rhizomatous plants of the banks; flowering is more prolific in the water where the floating leaves are obtuse or acute at the tips and usually slightly cordate at the bases; land plants are quite variable in leaf shape and pubescence; peduncles usually are glabrous on the floating shoots and glandular on those flowering on land; stipules in typical var. *amphibium* are not flanged, but many intermediates show this character; inflorescences 3–13 cm. long on the floating shoots, usually shorter on land; this is the entity which spans the gap in every character between the formerly described taxa.

Importance: The plants are harvested and dried for cattle and pig fodder in Western United States; in Thailand and other Asian countries this species (along with Water-hyacinth) is grown in ponds where swine feed on it; it has been used as a source for the flavanoid, rutin. Ecologically it is important as a food for waterfowl. It has the capability of invading impoundments and changing the ecosystem very quickly by its spread over the surface. In Europe the rhizomes are leached and the liquid substituted for sarsaparilla.





21. Polygonum lapathifolium L.

Common Names: Willow-weed, Dock-leaved or Pale Smartweed

Type Description: Linnaeus, Species Pl., p. 360, 1753

Synonyms: *P. scabrum* Moench., *P. tomentosum* Gray, *P. incarnatum* Ell., *P. nodosum* Pers.

Origin: Introduced from Europe; possibly native, in part

Habitats: Disturbed soils and moist places

Habit: Erect, ascending or prostrate in soil, gravel or on sidewalks

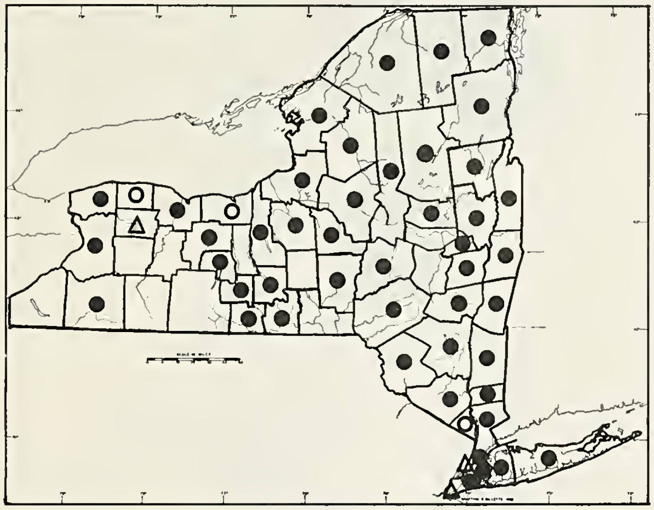
Flowering: June–October

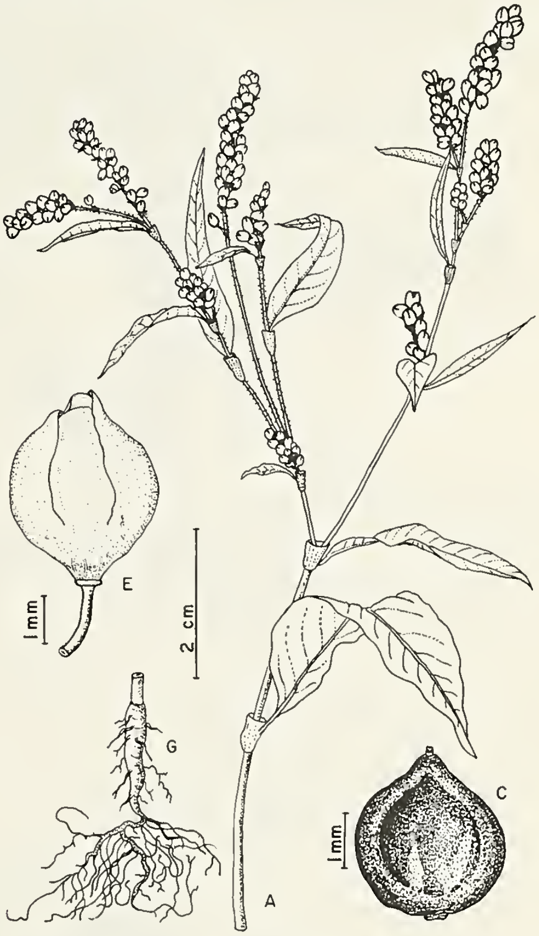
General Distribution: Widespread weed, circumboreal

Description: Plants with bisexual flowers; **stigmas** 2; **styles** 2, barely united at the base; **ovary** 1, becoming a lens-shaped achene; **achene** brown to black, lustrous, flattened with one slightly concave side, 1.8–2.8 mm. long, enclosed in the persistent perianth; **stamens** usually 6, included in the perianth; **perianth** 4 (5) lobed to below the middle, pinkish to white or green with a silvery sheen, 2.4–3.8 mm. long, constricted above the achene; most **lobes** with prominent, **anchor-shaped veins; bracts** oblique, scarcely tubular, entire or with a few short bristles; **inflorescence** 0.5–1.1 cm. wide, 1–7 cm. long, a spike-like panicle which is often nodding when elongate; **peduncles** glabrous or sparsely glandular; **leaves** usually lanceolate-acuminate, but varying from oblong-ovate to lance-linear, 5–25 cm. long, sometimes glandular dotted; **pubescence** ranging from none to sparse hairs and glands or even densely tomentose on the under surfaces; **petioles** 0.3–3.5 cm. long, glabrous to glandular-pubescent; **stipules** obliquely tubular with entire or lacerate margins; **nodes** swollen, especially the lower ones; **internodes** hollow; **stems** strongly erect-ascending to decumbent, up to 2.5 m. tall, from a twisted, annual **taproot** (2n = 22).

Infraspecific Variation: Pale-leaved, semi-prostrate plants are to be found on gravel heaps and in sidewalk cracks; these often have pronounced purple-brown splotches on the leaves. According to Timson (1963), characters used to distinguish species such as *P. nodosum* and *P. tomentosum* actually are found in all combinations in separate in-breeding lines; the variable properties are: red-spotted stems, yellow or pellucid glandular dots, tomentose leaves and anthocyanin in the perianth; inflorescence length and nodding, as well as peduncle glands are also sources of variation.

Importance: This species is a rank weed in disturbed situations throughout the Northern Hemisphere. Its value as a food for waterfowl is notable, but not as significant as in some other species.





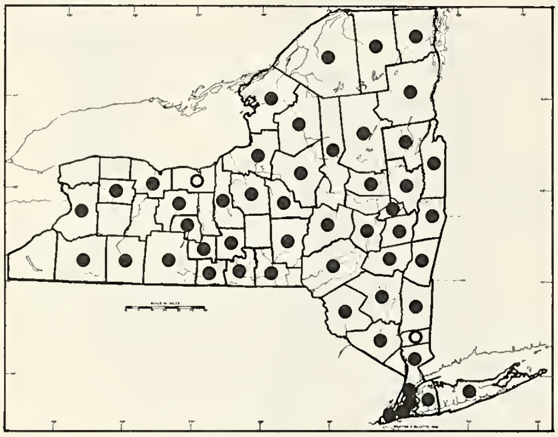
22. *Polygonum pensylvanicum* L.

Common Names: Pinkweed, Smartweed
Type Description: Linnaeus, Species Pl., p. 362, 1753
Synonyms: *P. bicorne* Raf., *P. longistylum* Small (also misspelled *P. pennsylvanicum)*
Origin: Native, North American
Habitats: A great number of disturbed situations, including cultivated fields
Habit: Coarse, erect annual forming patches (rarely decumbent)
Flowering: June–October
General Distribution: Throughout North America

Description: Plants with bisexual flowers; **stigmas** 2, capitate; **styles** 2; **ovary** 1, becoming a lens-shaped **achene**; achene ovoid in outline, flattened and indented on one or both sides, 2.5–3.4 mm. long, brown to black, shiny but minutely roughened; **stamens** usually 8, attached in the sinuses and at the edge of a lobed, glandular disc at the base of the ovary; **styles** and stamens not exceeding the perianth (in ours); **perianth** 5-lobed, divided to below the middle, 3–4 mm. (6 mm.) long, pink to rose (rarely white), enclosing the achene; **bracts** acute-tipped, sheathing, entire or minutely ciliate; **pedicels** exserted; **inflorescence** a dense, cylindric, spike-like panicle, 1–1.5 cm. wide, 1.8–5 cm. long (usually about 3 cm.); **peduncles** with glands, hairs, combinations or completely glabrous; **leaves** broadly to narrowly lanceolate with acute to acuminate tips and obtuse to acute bases, 3–20 cm. long, 1–6 cm. wide, with variable pubescence ranging from nearly glabrous to densely hispid or glandular; **petioles** 3–15 mm. long joining smoothly with the stipules; **stipules** tubular-cylindric, many veined, sparsely pubescent or usually glabrous with no marginal bristles, soon lacerate, 1–1.5 cm. long; **nodes** conspicuously swollen; **internodes** hollow, strigose or glandular toward the plant apex (rarely glabrous); **stems** erect-ascending, up to 2.3 m. tall (rarely decumbent), main axis from a stout **taproot.**

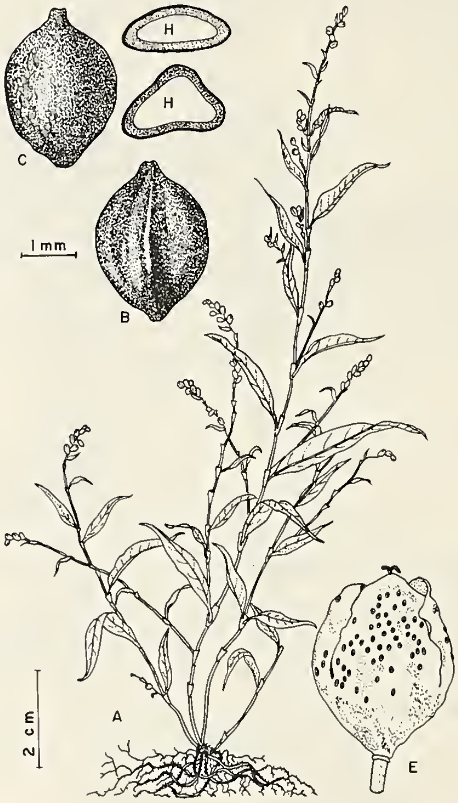
Infraspecific Variability: A number of varieties have been named on the basis of pubescence, glands, flower size and color. The prostrate form has also been recognized as a variety. The most common type in New York is var. *laevigatum* Fern. in which peduncles are glandular and leaves are almost glabrous beneath. In southern and western states the inflorescences of many populations are quite narrow and elongate; heterostylous populations have also been recognized as species. This polymorphic group is in need of further study.

Importance: This species is one of the more important to wildlife, with large, nutritious achenes produced in abundance, the plants form large colonies in ecotones where upland gamebirds find both protection and food; they also occur in cultivated fields and wet places where migratory waterfowl may find them; they are planted by hunting clubs across the country; Pinkweed has been used along with *Lespedeza* as an early crop for roadcuts which need stabilization while a perennial soilbinder establishes; as a native plant, now spreading as a weed, it should not be discouraged where it might be replaced by far less attractive and useful opportunists.



23. *Polygonum hydropiper* L.

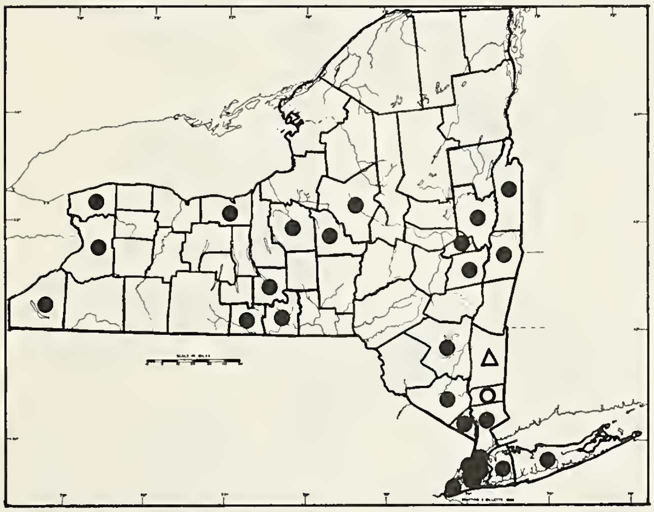
Common Names: Common Smartweed, Water Pepper
Type Description: Linnaeus, Species Pl., p. 361, 1753
Synonym: *Persicaria hydropiper* (L.) Opiz.
Origin: Eurasia
Habitats: A great variety of moist and disturbed situations including fields and meadows
Habit: Erect to sprawling
Flowering: June–October
General Distribution: A circumboreal weed

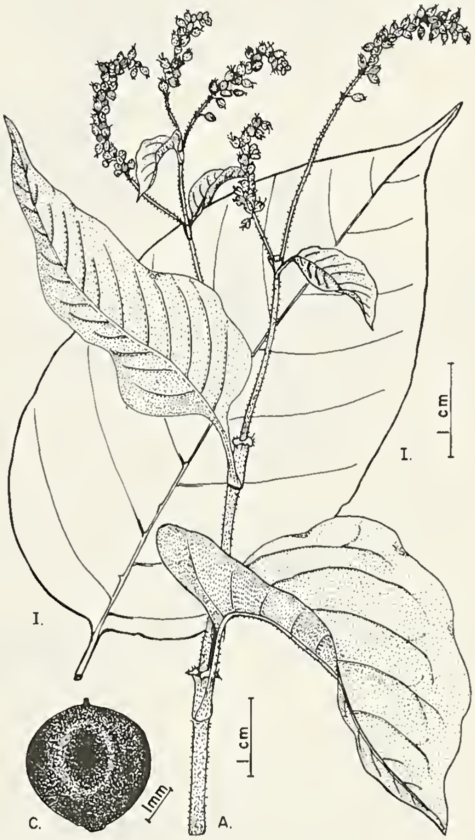


Description: Plants with bisexual flowers (mostly cleistogamous); **stigmas** (2) 3, capitate; **styles** (2) 3, short; **ovary** 1, developing into a lens-shaped or more frequently 3-angled **achene**; achene powdery to dark brown, surface dull, 2–3.5 mm. long, enclosed in or slightly exserted from the perianth; **stamens** 6–8, included; **perianth** 4 (5) lobed to below the middle, 2.5–4.5 mm. long, outer lobes cucullate, greenish with creamy margins, often with roseate blush, covered with glandular dots (valvate chambers) which are yellow-green and turn brown upon drying; **bracts** sheathing and usually overlapping-turbinate, green to pink with entire or weakly ciliate margins; **inflorescences** numerous, 0.3–7.5 cm. long, slender, spike-like panicles and smaller clusters borne from the nodes within the sheathing stipules; **peduncles** variable in length, usually glabrous; **leaves** lanceolate, 1–16 cm. long, 0.3–2.0 cm. wide, reduced in size upward on the plant continuing into the inflorescence as foliacious bracts, pubescent with short, stiff hairs along the margins and a few veins, otherwise glabrous, punctate on both surfaces, anthocyanin rich, tending to color with age; **petioles** 1–5 mm. long with a few hairs, joined near the bases of the stipules, strongly veined in transition; **stipules** tubular-cylindric with scabrous surfaces and slender marginal bristles, 1–6 mm. long, browning and shattering with age, 1–1.5 cm. long; **nodes** swollen; **internodes** hollow, surfaces usually glabrous; **stems** up to 1 m. high, spreading-erect to sprawling, single to **many-stemmed,** branching profusely near the base, from a fibrous, annual **root system** (2n = 20, 22).

Infraspecific Variation: North American plants have been segregated as var. *projectum* Stanford, but do not differ from European populations significantly. Perennials have been reported, but these probably represent improperly identified specimens of *P. punctatum* Ell., which is similar.

Importance: In Europe an extract has been used medicinally for centuries, due to its irritant properties, which can alter a number of medical symptoms. The oily exudates, which are produced throughout the plant in multicellular glands (valvate chambers), are released onto the epidermis and repel most foraging animals; this irritation can be extreme, causing temporary blindness if wiped directly in the eyes. The name, Smartweed, derives from this characteristic. Songbirds and waterfowl, however, feed enthusiastically on the achenes. The old name, Water Pepper, comes from the occasional use of the achenes by Europeans as a substitute for ground pepper in seasoning. Polygonic acid is given credit for the exudate's irritant properties. The extract was used in the 18th century as a yellow dye for wool. In America an extract of fresh plants has been tried with mixed, and often doubtful results, as a stimulant, vesicant, anti-venereal, laxative, cold cure, dessicant, cholera treatment, diuretic, and soak for rheumatics. It has been used externally for inflammations, bruises, ulcers and hemorrhoidal inflammations, also in shrinking gangrenous tissue; as a general cure-all, it has been included in a number of panaceas, sold in medicine shows in the 19th century. Fresh juice was claimed to help with jaundice and dropsy; the root was chewed for toothache, probably as a distraction. All of these claims should be carefully scrutinized, and the extract of Smartweed should be treated with caution for what it is . . . a strong irritant and astringent. As a weed, this species is a common inhabitant of moist, disturbed sites, and has become a problem in some meadows and cultivated fields; it is controlled through weeding and increased soil drainage.



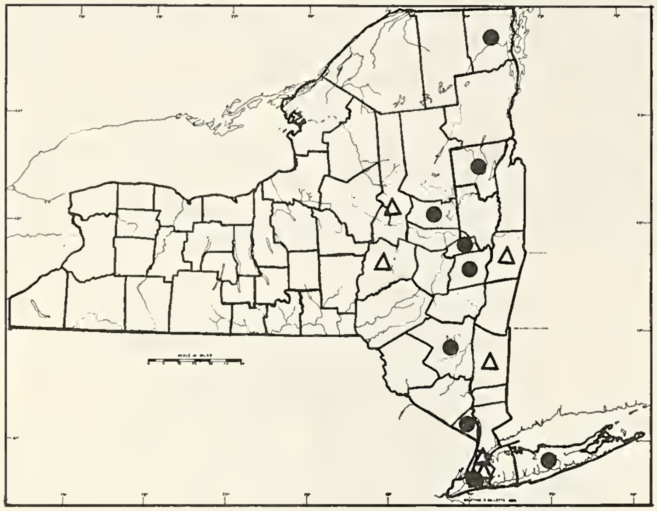


24. *Polygonum orientale* L.

Common Names: Prince's-feather, Kiss-me-over-the garden-gate, Baton de St. Jean, Monte-au-ciel
Type Description: Linnaeus, Species Pl., p. 362, 1753
Synonym: *Persicaria orientalis* (L.) Spach
Origin: Native of India, introduced as an ornamental
Habitats: Moist and disturbed ground as an escape
Habit: Tall, erect, branching annual
Flowering: June–October
General Distribution: Circumboreal weed and cultivar

Description: Plants with bisexual flowers; **stigmas** 2, capitate; **styles** 2; **ovary** 1, becoming a biconvex **achene**; achene orbicular, turgidly lens-shaped or indented on one or both sides, dark brown to black, semi-lustrous, 2.5–3.2 mm. long and broad, included; **stamens** 6–8, included or slightly exserted; **perianth** 5-lobed to below the middle, pink to deep rose, 3–4.5 mm. long, enclosing the achene; **bracts** ovate with acute to obtuse tips, usually overlapping, minutely strigose on the surfaces with bristles on the margins; **inflorescence** a spike-like panicle about 1 cm. wide and up to 12 cm. long, often lax or slightly drooping; **peduncles** 2–5 cm. long, densely pilose-tomentose; **leaves** ovate, commonly acuminate tipped and slightly truncated below, 3–16 cm. wide, 6–25 cm. long, drastically reduced upward on the stem, minutely strigose to densely tomentose, especially on the lower veins; **petioles** ribbed or slightly winged, 1–8.5 cm. long, densely pilose-hispid; **stipules** 1–1.5 cm. long, tubular-sheathing, densely strigose to hispid with marginal bristles, scarious, sometimes with a flared, chlorophyllous flange at the summit; **nodes** swollen; **internodes** pilose-hispid, terete or grooved; stems up to 2.5 m. tall from a tough, annual **rootstock** (2n = 22, 24).

Importance: The plants are cultivated as garden annuals, and occasionally escape and persist as weeds of moist, waste places and vacant lots.



25. *Polygonum careyi* Olney

Common Names: Smartweed, Pinkweed

Type Description: Olney, Proc. Prov. Frankl. Soc., 1:29, 1847

Synonym: *Persicaria careyi* (Olney) Greene

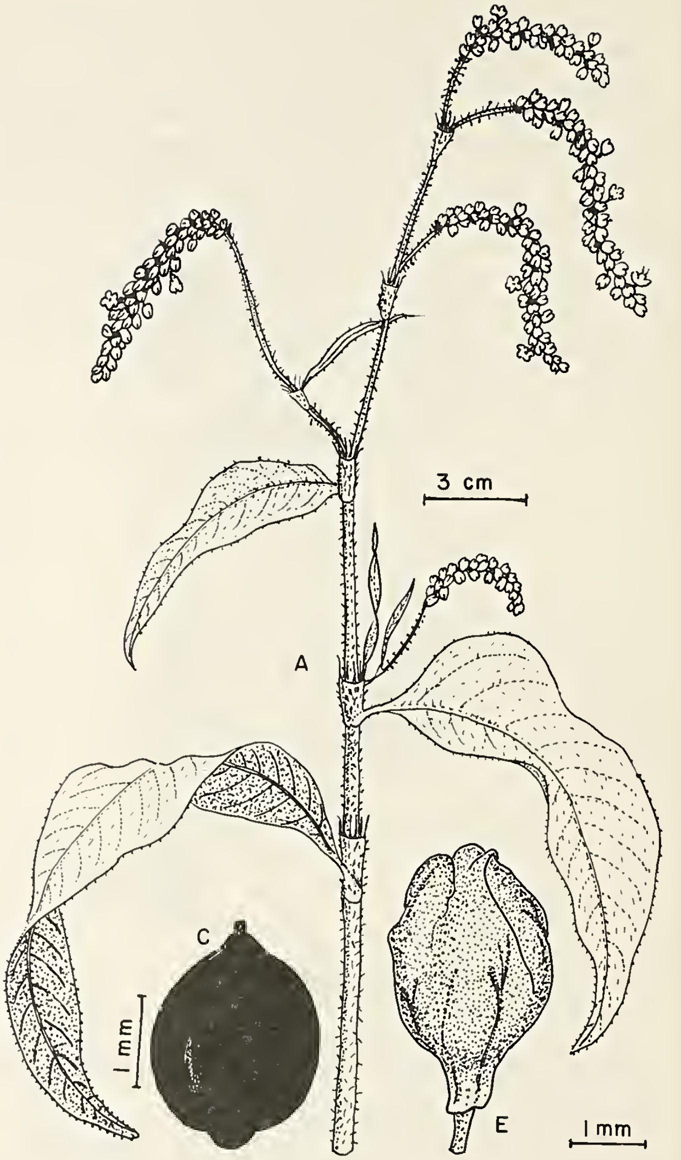
Origin: Northeastern North America

Habitats: Moist ground, fields, meadows thickets, riverbeds and other disturbed soils

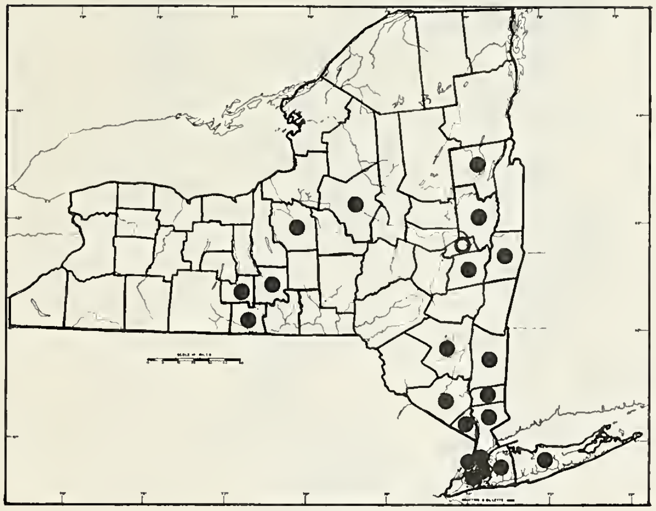
Habits: Erect-ascending, robust annual (dwarfed on gravel)

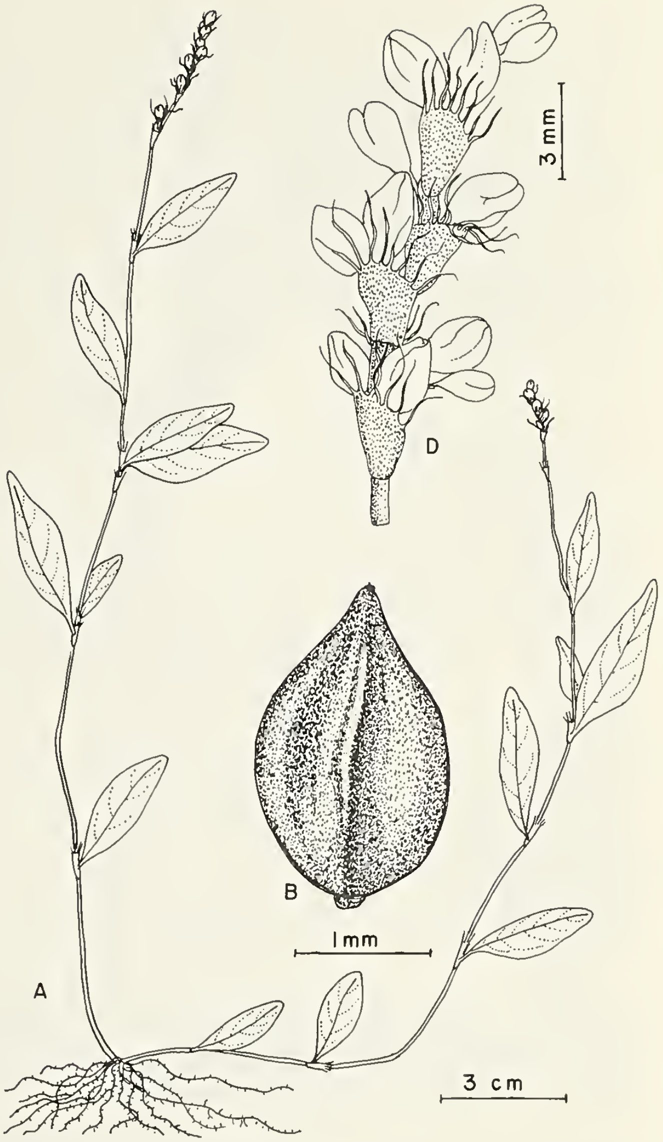
Flowering: July–October

General Distribution: Maine to Minnesota, Delaware to Indiana



Description: Plants with bisexual flowers; **stigmas** 2, capitate; **styles** 2; **ovary** 1, becoming a lens-shaped **achene;** achene obovoid, lustrous, dark brown to black, 1.8–2.5 mm. long, nearly as wide; **stamens** 5 (8) not exserted; **perianth** 5-lobed, pink to dark rose or purplish, 2.4–3.2 mm. long, parted to below the middle, enclosing the mature achene; **pedicels** exserted from the bracts; **bracts** sheathing with ciliate margins; **inflorescences** spike-like panicles, loosely flowered and sometimes lax or slightly drooping, 3–10 cm. long; **peduncles** strongly glandular-pubescent, variable in length; **leaves** narrowly lanceolate, 6–18 cm. long, 1–3 cm. wide, attenuated at both ends, pilose to scabrous; **stipules** tubular-cylindric, bristled at the margins and occasionally slightly flanged, scabrous to hirsute or slightly glandular; **nodes** swollen; **internodes** densely glandular-stipitate, especially the upper ones, also with hairs among the glands; stems up to 1.5 m. tall, usually erect branching from an annual **rootstock.**





26. *Polygonum cespitosum* Blume

Common Name: Smartweed

Type Description: Blume, Bijdr., p. 532, 1825

Synonyms: *P. longisetum* DeBruyn (also spelled *P. caespitosum*), *P. posumbu* Hamilt.

Origin: Southeastern Asia

Habitats: Moist places and disturbed ground

Habit: Erect to spreading-procumbent, annual

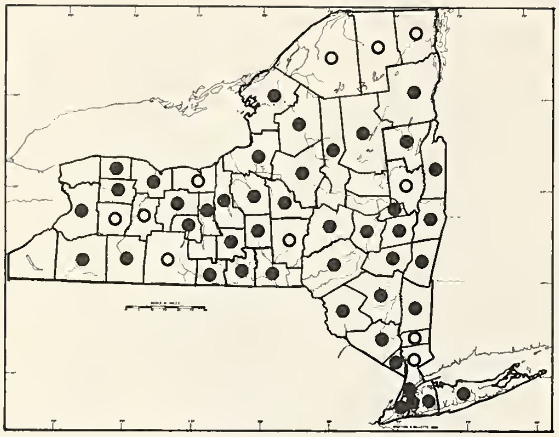
Flowering: June–October

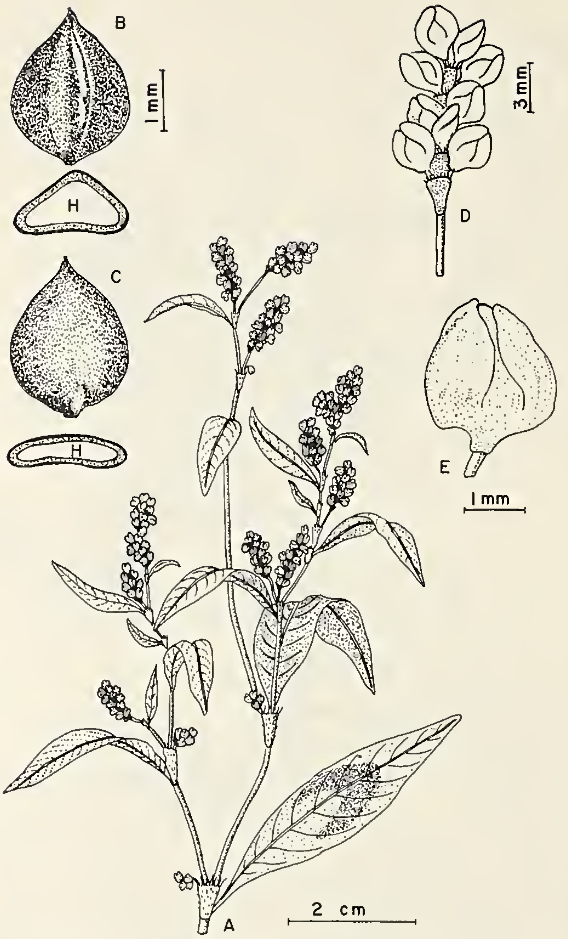
General Distribution: Eastern Asia, weedy in Europe, New England to the Carolinas and Midwestern United States

Description: Plants with bisexual flowers; **stigmas** 3, capitate; **styles** 3; **ovary** 1, becoming a 3-angled **achene**; achene 2–2.5 mm. long, lustrous, dark brown to black; **stamens** usually 8, included in the perianth; **perianth** 2.2–2.8 mm. long, dull rose to deep rose-purple with paler lobe margins, 5-lobed to about the middle, enclosing the mature achene; **bracts** sheathing, with long bristles, 2–4.5 mm., exceeding or equaling the flowers in length; **inflorescences** slender, cylindric, spike-like panicles 3–6 mm. wide, 2–4.5 cm. long; **peduncles** slender; **leaves** ovate-lanceolate to rhombic, attenuated about equally at the tips and bases, 2–8 cm. long, 1–2 cm. wide, usually sessile, nearly glabrous above, ciliate on the veins below; **petioles** lacking or extremely short; **stipules** tubular, sheathing, glabrous to strigulose, but with bristles up to 1 cm. in length on the margins, equaling to longer than the stipules themselves; **nodes** swollen; **internodes** slender, glabrous; **stems** branching from near the base, erect to procumbent, from an annual **root.**

Infraspecific Variability: Collections from New York are of the type with long bristles in the inflorescence; these have been designated var. *longisetum* (DeBruyn) Stewart. In Asia the typical variety of the species has shorter bristles. This variety has also been reported as an introduction in the United States and may be encountered.

Importance: A weedy species, rapidly spreading in the United States since the 1940's, it provides some wildlife food and has been planted for the purpose, but it is mostly a pest.





27. *Polygonum persicaria* L.

Common Names: Lady's Thumb, Heart's-ease, Smartweed, Heartweed

Type Description: Linnaeus, Species Pl., p. 361, 1753

Synonyms: *P. puritanorum* Fern. (in the sense of American authors, also *P. dubium* Stein, *P. minus* Huds.)

Origin: Europe

Habitats: Disturbed soils and moist areas such as ditches and banks or rivers and lakes

Habit: Erect, ascending, annual weed

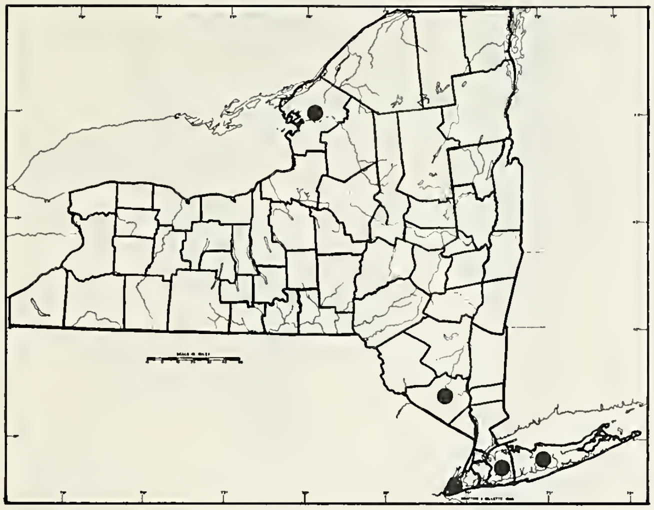
Flowering: June–October

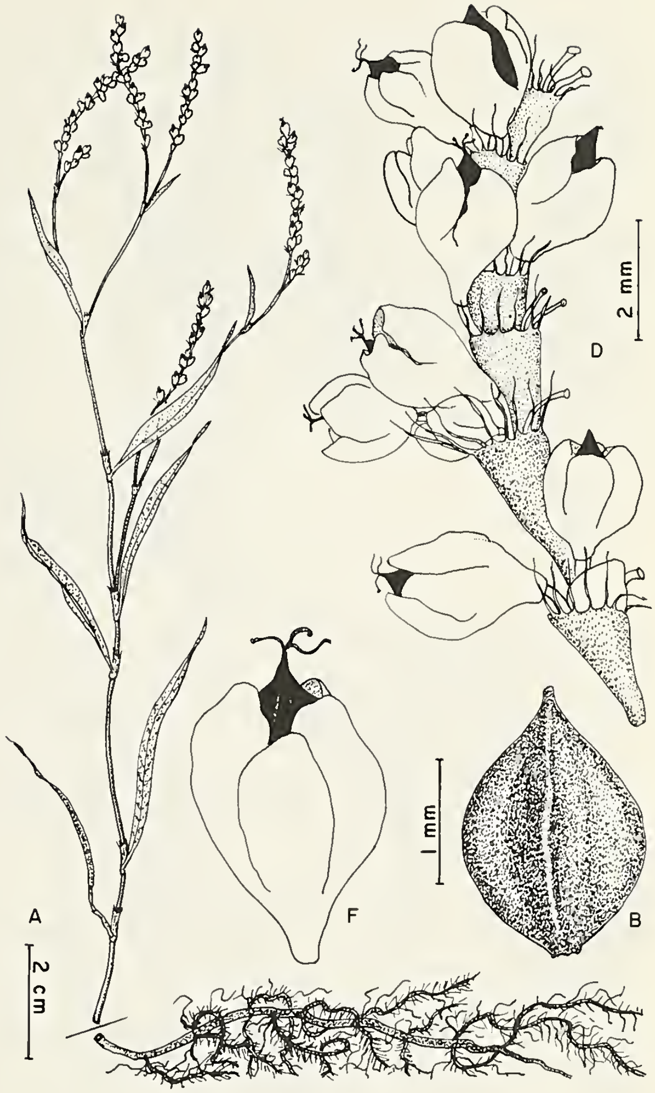
General Distribution: Circumboreal, Alaska to Mexico, Greenland to Florida in North America

Description: Plants with bisexual flowers; **stigmas** 2 (3), capitate; **styles** 2 (3) united at the base; **ovary** 1, becoming a lens-shaped or 3-angled **achene** (in different percentages); achenes ovoid, 2–3 mm. long, brown to black, lustrous, but minutely pitted; **stamens** usually, 6, included or slightly exserted in open flowers; **perianth** 5-parted to below the middle, pink to greenish-purple (rarely white), 2.2–3.5 mm. long, enclosing the achene at maturity; **pedicels** short, included in the bracts; **bracts** sheathing, overlapping margins entire or with few weak cilia; **inflorescences** dense, cylindric, spike-like panicles, 7–12 mm. thick, 1–4.5 cm. (6) long, erect; both long, terminal inflorescences and shorter, scattered ones present at the nodes and on short shoots; **peduncles** glabrous; **leaves** broad to linear-lanceolate, often purple blotched near the middle, 3–15 (20) cm. long, 3–18 (26) mm. wide, sparsely strigose to nearly glabrous, acuminate-acute tipped (rarely obtuse to blunted) tapering at the base; **petioles** short, usually glabrous; **stipules** sheathing, tubular-cylindric, 1–2 cm. long, membranous and strigulose with short, marginal bristles, shattering with age; **nodes** swollen; **internodes** mostly glabrous; **stems** branched up to 1 (1.5) m. tall, from an annual **taproot** (2n = 44, 40?).

Infraspecific Variation: There is a great deal of variation in leaf shape and stature of the plants, which has lead to description of such taxa as var. *angustifolium* Beckh. and var. *ruderale* (Salisb.) Meisn. Species and varieties have been based in part also on the percentage of 3-angled achenes; however, this character has been shown to be strongly environmentally influenced (Hammerton and Jalloq, 1970). Large specimens with elongate inflorescences from the streets of New York City resemble Texas populations, and have probably been re introduced at the docks. Inflorescence color and interruption of the spikes have also been used as characters, but show more or less random variation.

Importance: The plants are noxious weeds, but provide food for waterfowl and other birds; they are sometimes sown for the purpose in ponds and estuaries; they spread rapidly by seed in moist areas and also survive on waste dumps and on city streets; the species is perhaps our commonest Smartweed, followed closely by *P. lapathifolium*, with which it is often confused; the leaves are somewhat peppery, and have been used to season cooking; a yellow to grey-brown dye-stuff extracted from this and other species was used in the 19th century.





28. *Polygonum opelousanum* Ridd. ex Small

Common Name: Smartweed

Type Description: Riddell, in Small, Bull. Torrey Bot. Club, 19:354, 1892

Synonyms: *Persicaria opelousana* (Ridd.) Small, *Polygonum hydropiperoides* Michx. var. *opelousanum* (Ridd.) Stone

Origin: Southeastern Coastal Plain of the United States

Habitats: Wet, sandy to peaty soils near running water, swales

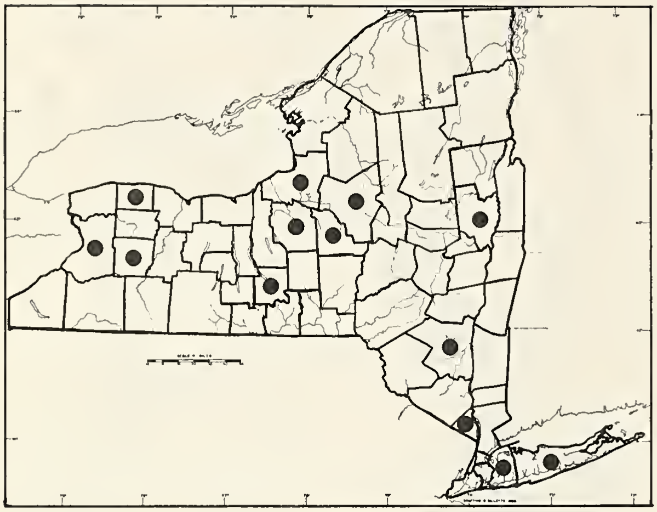
Habit: Erect, slender perennial

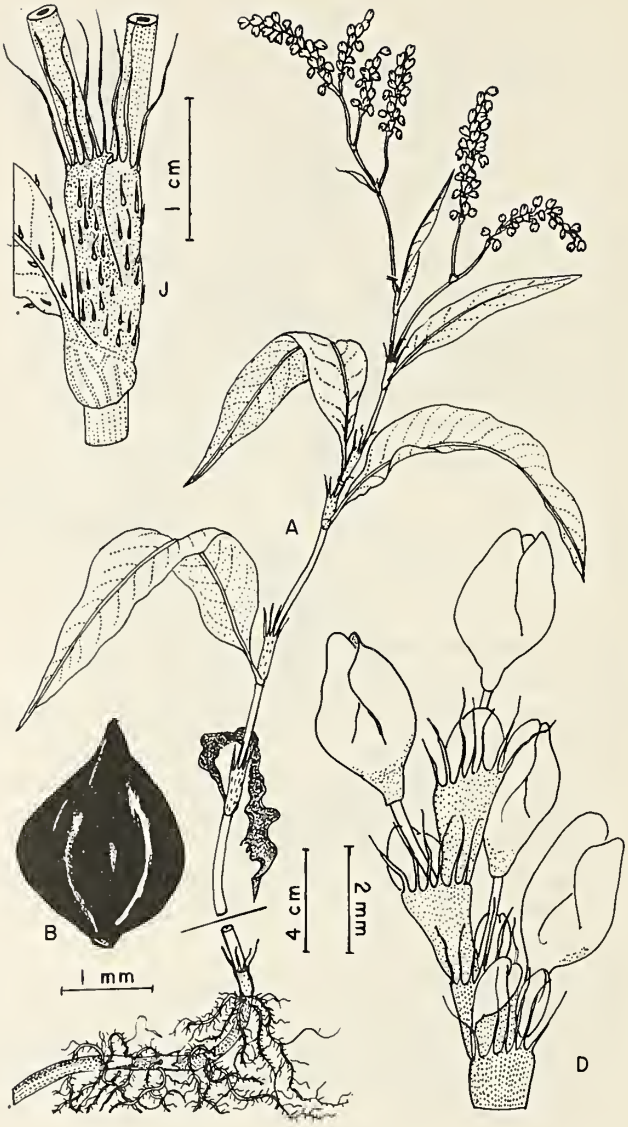
Flowering: July–October

General Distribution: Coastal Plain, Florida inland to Oklahoma, north to Long Island and the Massachusetts coast

Description: Plants with bisexual flowers; **stigmas** 3, capitate; **styles** 3, partially united; **ovary** 1, becoming a 3-angled **achene;** achene 1.5–2.5 mm. long, 1.3–2.3 mm. wide, often slightly exserted, brownish-black, lustrous; **stamens** 8, included in the perianth; **perianth** 5-lobed to below the middle, ovoid-spheroid in outline with the outer lobes incurved-cucullate at maturity, not enclosing the achene tip, flowers 1.5–2.5 mm. long, greenish at the base, tips creamy or rose to purple-tinged (not pink), sometimes with a few pale, scale-like glands unevenly spaced (not evenly punctate); **bracts** overlapping, sheathing with bristles 1–2 mm. long, on the margins; **inflorescences** usually continuous, dense, spike-like panicles, 3–6 mm. wide, 2–6 cm. long, not lax; **peduncles** glabrous to strigulose; **leaves** linear-lanceolate, 0.5–2.3 cm. wide, 5–15 cm. long, glandular beneath with blue-green to yellow, scale-like glands of the type occasionally found on the perianth, leaf undersurface more scabrous than the upper; **petioles** often scabrous, short; **stipules** tubular-sheathing, strigose with tough marginal bristles up to 8 mm. long; **nodes** swollen; **internodes** glabrous or strigulose; **stems** up to 1.3 m. high, usually branched, erect, wiry, from a perennial **rhizome** (2n = 40).

Note: Although leaves tend to be narrower than those of its near relative, *P. hydropiperoides* Michx., they may sometimes be broadly lanceolate. The characteristic plate-glands of *P. opelousanum* are usually found only on the vegetative parts, but are occasionally found on the perianth (var. *adenocalyx* Stanford). Though there may eventually be enough evidence to recognize this species as a variety of *P. hydropiperoides*, it is retained here on the basis of: perianth shape and achene exsertion (high percentages), plate-glands on the leaves, more wiry, erect habit and a habitat preference which defines its range. The species is rare in New York, occurring primarily on Long Island.





29. *Polygonum setaceum* Baldw. ex Ell.

Common Name: Smartweed

Type Description: Baldwin, in Elliott, Sketch Bot. S.C. and Ga. 1:455, 1817

Synonyms: *Persicaria setacea* (Baldw.) Small, *Polygonum hydropiperoides* Michx. var. *setaceum* (Baldw.) Gleason

Origin: Eastern United States

Habitats: Lake margins, swampy forests

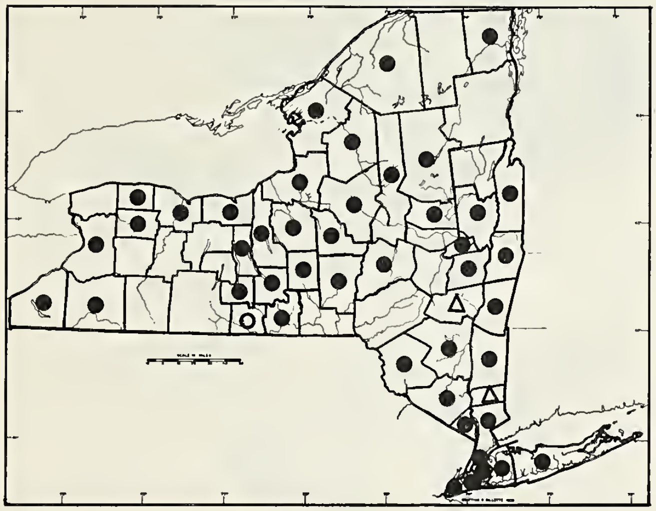
Habit: Erect-ascending, robust perennial (may be mat-forming in lakes in New York)

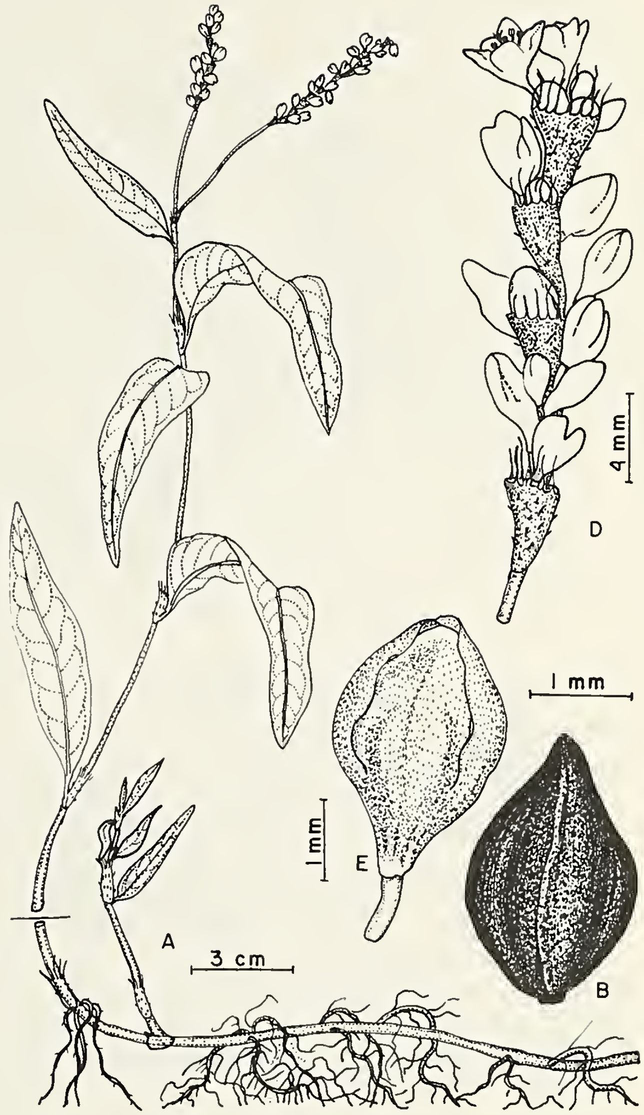
Flowering: July–October

Distribution: New York to Florida, west to Eastern Oklahoma

Description: Plants with bisexual flowers; **stigmas** 3, capitate; **styles** 3; **ovary** 1, becoming a 3-angled **achene;** achene 2–3 mm. long, brown to black, lustrous; **stamens** 8, included in the perianth; **perianth** 5-lobed, 3–3.5 mm. long, enclosing the achene, greenish at base with creamy to tan lobes, occasionally rose-tinged (not pink); **bracts** sheathing, ciliate margined; **inflorescences** usually uninterrupted, elongate, spike-like panicles, 3–6 mm. wide and 2–8 cm. long, single or usually several per apex; **peduncles** strigose, often 2-several from a given point on the axis (sometimes broom-like); **leaves** lanceolate, 7–20 cm. long, up to 4.8 cm. broad, usually strigose to hispid, but affected by water contact (rarely almost glabrous); **stipules** tubular-sheathing, slightly inflated at the base, 1–2 cm. long, with long, appressed hairs or minutely strigose (in ours), marginal bristles stiff, often twisted, up to 1.2 cm. long; **nodes** strongly swollen; **internodes** thick, the lower ones enlarged and somewhat woody in older plants; stems up to 1.5 m. tall from a tough, woody **rhizome** (occasionally stoloniferous in water), perennial (2n = 20?).

Infraspecific Variation: New York plants correspond with other northern populations which have been designated var. *interjectum* Fern. Leaves are uniformly short-haired, and the most characteristic property of the species is lacking: ours have no hispid fringes, formed by the long-spreading hairs of the stipules. Phenotypic variation has also been demonstrated with regard to pubescence and other leaf properties, when plants grow in contact with water (Mitchell, 1971, 1976). Glabrous var. *tonsum* Fern. appears to be merely a modification of this sort. Plants also vary in robustness and clustering of the inflorescences. In the northern part of the range *P. setaceum* is less easily distinguished from *P. hydropiperoides* Michx., whereas southern and midwestern populations have obvious hispid fringes, greenish-white flowers and grow in partially shaded swamp forests.





30. Polygonum hydropiperoides Michx.

Common Names: Mild Water Pepper, Water Smartweed

Type Description: Michaux, Fl. Bor. Amer. 1:239, 1803

Synonyms: *Polygonum mite* Pers. (not Schrank), *Persicaria hydropiperoides* (Michx.) Small

Origin: North America

Habitats: A great variety of semi-aquatic situations, usually in full sunlight

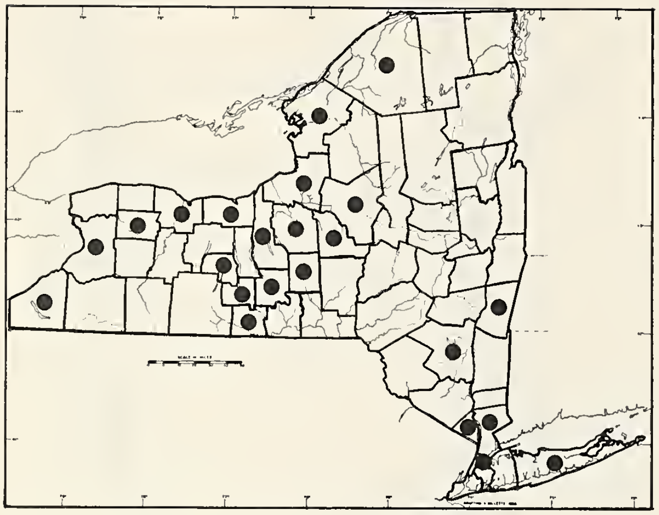
Habit: Ascending from decumbent stoloniferous bases, or erect when young, perennial

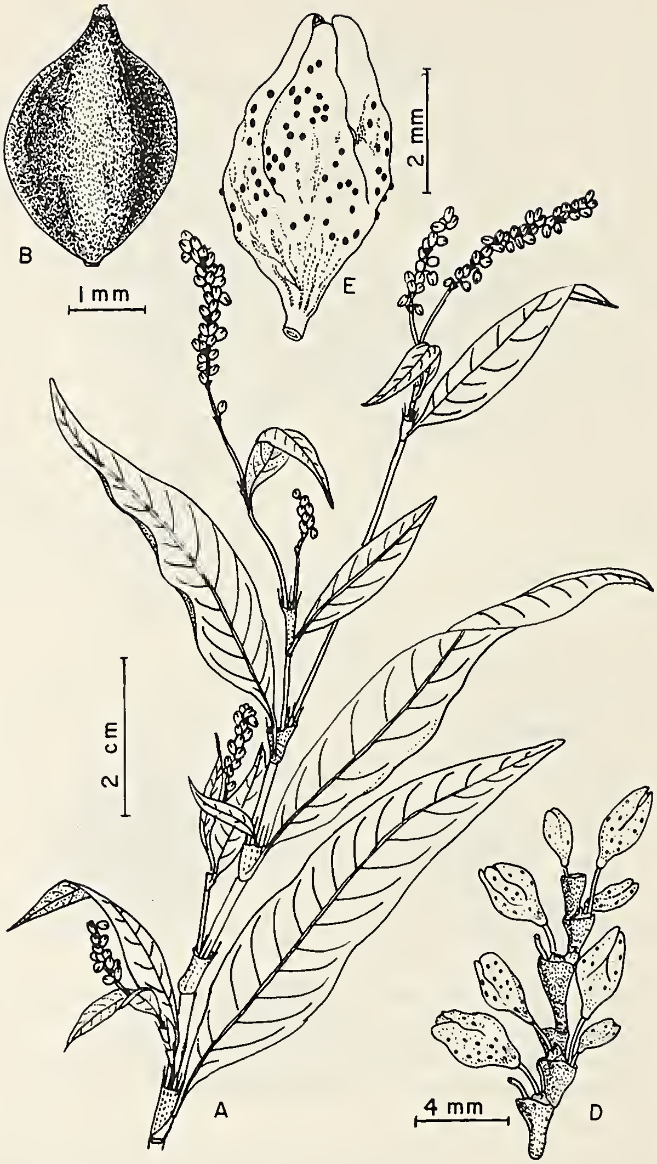
Flowering: July–October

General Distribution: Throughout most of North America

Description: Plants with male and bisexual flowers; **stigmas** 3, capitate; **styles** 3, partially united; **ovary** 1, becoming a 3-angled **achene;** achene sharply angled with flat to concave sides, 2–3 mm. long, nearly as wide, dark brown-black, lustrous, enclosed in the perianth; **stamens** usually 8, not exserted except in young, male flowers; **staminate flowers** 1.5–2.5 mm. long; **perfect flowers** with perianths becoming 2.5–4 mm. long in fruit, 5-lobed to just below the middle, roseate below to pink or creamy white at the lobe tips (rarely greenish, purplish or white), completely enclosing the achene; **bracts** pinkish-green, sheathing, with ciliate margins; **inflorescences** elongate, spike-like racemes, usually interrupted near the base, 2–5 mm. wide, 3–8 cm. long at maturity, erect; **peduncles** glabrous to scabrescent or strigose, 1–3 cm. long, slender; **leaves** broadly lanceolate to lance-linear, 0.4–3.5 cm. wide, 5–25 cm. long, with truncated obtuse to acute bases and acuminate tips, strigose, glabrous or nearly glabrous except for the margins; **petioles** 2–20 mm. long, variably pubescent; **stipules** tubular-cylindric, scarious, strigose or scabrous 1–3.5 cm. long, with tough, marginal bristles 3–8 mm. long; **nodes** swollen, adventitiously rooting; **internodes** elongate, glabrous to strigose; **stems** slender, stoloniferous-decumbent, but with strongly ascending tips, from a much-branched, perennial **rhizome** (2n = 40).

Infraspecific Variation: A number of varieties have been named (see Fernald, 1950) based on pubescence differences, leaf shape and inflorescence disposition. Very strigose populations of slender plants have been called f. *strigosum* (Small) Stanf.; these are often wrongly identified as *P. setaceum* Baldw. White, greenish and purplish-flowered forms have also been recognized. The group, including the closely related *P. setaceum* and *P. opelousanum*, forms a widespread, polymorphic complex in need of much further study.



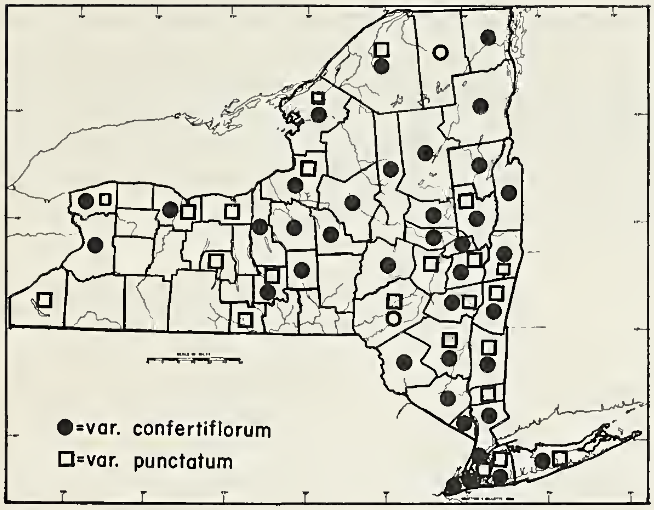


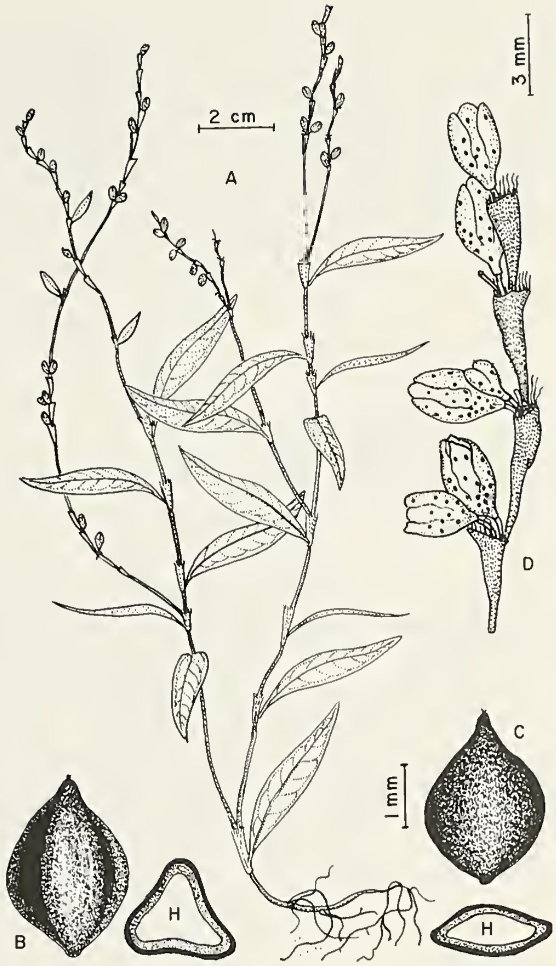
31. Polygonum robustius (Small) Fern.

Common Name: Water Smartweed
Type Description: Fernald, Rhodora 23, 147, 1921
Synonyms: *Polygonum punctatum* var. *robustius* Small, *Polygonum punctatum* var. *majus* (Meisn.) Fassett, *Persicaria robustior* (Small) Bickn.
Origin: Probably North American Coastal Plain
Habitats: Wet soils and shallow water, swampy areas, stream and lake margins
Habit: Stout, erect perennial from a creeping rhizome
Flowering: July–October
General Distribution: Nova Scotia to Florida, down the eastern flyway to South America

Description: Plants with bisexual flowers; **stigmas** 3, capitate; **styles** 3, partially united; **ovary** 1, becoming a 3-angled **achene** (rarely lens-shaped); achene 2.7–3.6 (4) mm. long, oblong, tapered at both ends, with 3 concave sides, dark brown-black, lustrous; **stamens** 6–8, included; **perianth** 5-parted to well below the middle, greenish at the base with cream to white lobes, 3.2–4.2 mm. long, enclosing and surpassing the achene in length, strongly **glandular-punctate** (valvate chambers) with glands which are yellow-green and dry brownish; **pedicels** often exserted from the bracts; **bracts** sheathing, usually all overlapping (or only the lower 1–2 remote) eciliate (except lowermost) with truncate, entire margins; **inflorescences** uninterrupted (except occasionally lowest fascicles), spike-like, cylindric panicles, single or clustered 2–8 cm. long 4–8 mm. wide, erect; **leaves** 4–20 cm. long, 2–4.5 cm. wide, robust, lance-elliptic to lanceolate with tapered bases and acuminate tips, virtually glabrous except for scabrescent margins and some veins; **petioles** 2–7 mm. long, dilated at base; **stipules** tubular-cylindric, close-sheathing above but inflated somewhat below, strigose with stiff, marginal bristles 3–8 mm. long; **nodes** conspicuously swollen near the plant base, sprouting vegetatively in the fall; **internodes** stout, glabrous; **stems** ascending, up to 2 m. tall, from a branching woody **rhizome.**

Importance: Like its relative, *P. punctatum* Ell., this species is a good source of food for waterfowl which relish the achenes. Its tendency toward stronger vegetative reproduction makes it less efficient in this than the former species when total biomass is considered.





32. *Polygonum punctatum* Ell.

Common Name: Water Smartweed

Type Description: Elliott, Sketch Bot. S.C. and Ga., 1:455, 1817

Synonyms: *Polygonum acre* H.B.K., *Persicaria punctata* (Ell.) Small

Origin: Probably North America

Habitats: Moist ground and shallow waters

Habit: Ascending-erect from prostrate stolons and rhizomes or a suberect annual

Flowering: June–October (New York)

General Distribution: North, Central and South America

Description: Plants with bisexual flowers; **stigmas** 2–3, capitate; **styles** 2–3, partially united; **ovary** 1, becoming a lens-shaped or 3-angled **achene;** achene ovoid-elongate, 2.5–3 mm. long, brown to black, lustrous; **stamens** 6–8, included; **perianth** 5-parted to below the middle, greenish at the base with creamy lobes, 3–3.5 mm. long, enclosing the fruit at maturity, covered with **glandular dots** (valvate chambers) which are yellow-green and dry brown; **bracts** sheathing, often remote, not overlapping in continuous series, ciliate-margined; **inflorescences** interrupted, spike-like panicles (one variety with long, many flowered axes and numerous shorter inflorescences scattered) terminal ones 1–5 mm. wide up to 20 cm. long but most often around 7 cm., interrupted occasionally by tiny leaves; **leaves** lanceolate-ovate to subrhombic, cuneate at the bases (in ours) with acute tips 4–10 (15) cm. long, 6–24 mm. wide, drastically reduced in and near terminal inflorescences, glandular-punctate, scabrescent to glabrous except the margins; **petioles** short, abruptly dilated; **stipules** tubular-cylindric, 9–18 mm. long, strigulose or glabrous, but with bristles at the margin, rupturing with swelling of the **nodes; internodes** slender, elongate, up to 10 cm.; **stems** ascending-erect, up to 1.2 m. tall, from horizontal stolon and rhizomes or an annual **rootstock.**

Infraspecific Variation: A large number of varieties of this species have been named in North and South America. Of the three which have been recorded for New York State, the least reliable is var. *parvum* Fassett, which appears to be a depauperate form. Though our two major varieties have intermediates, most plant populations may be distinguished as in the following key:

KEY TO VARIETIES

1. Plants perennial, from a creeping rhizome; inflorescences relatively uniform in size and terminal to leafy branches; achenes predominantly 3-angled .... *P. punctatum* Ell. var. *punctatum*
1. Plants annual from a small taproot (or slightly creeping); some inflorescences quite elongate, branch-like, from lower nodes; achenes predominantly lens-shaped............ *P. punctatum* Ell. var. *confertiflorum* (Meisn.) Fassett

Importance: Our most common, native Smartweed; extremely valuable as a food for birds, especially waterfowl.

Waifs: *Polygonum polycnemioides* Jaub. and Spach, was collected once around carpet mills in Yonkers in 1894 (E. P. Bicknell, s.n., NY); it has not been collected since that time, and probably did not persist. Another specimen superficially similar, but lacking the technical characters, was collected near Barton (Tioga County) in 1900 by F. E. Fenno. This specimen was cited by House (1924) and referred to *P. aviculare* var. *crassifolium* Lange. It actually bears little resemblance to *P. aviculare*, but is more similar to a species-complex in the Russian flora. Its identity has yet to be determined. Two additional species are found near gardens, but are doubtfully naturalized: *P. aubetertii* L. Henry (Monroe, Ulster Counties; *P. polystachium* Meisn. (Ulster County).

4. FAGOPYRUM

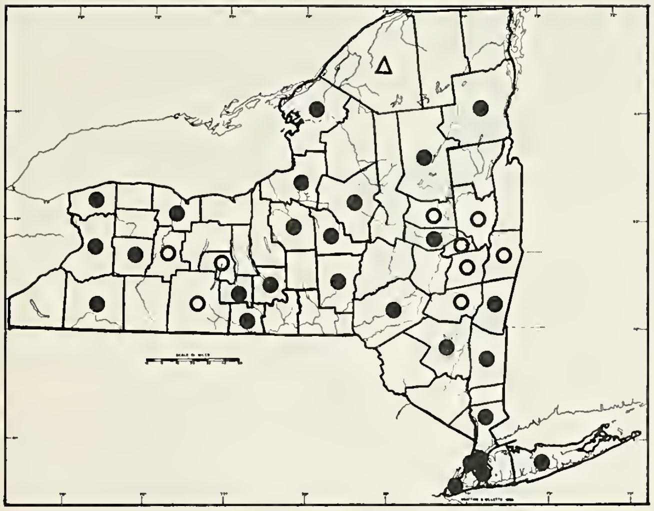
Common Name: Buckwheat

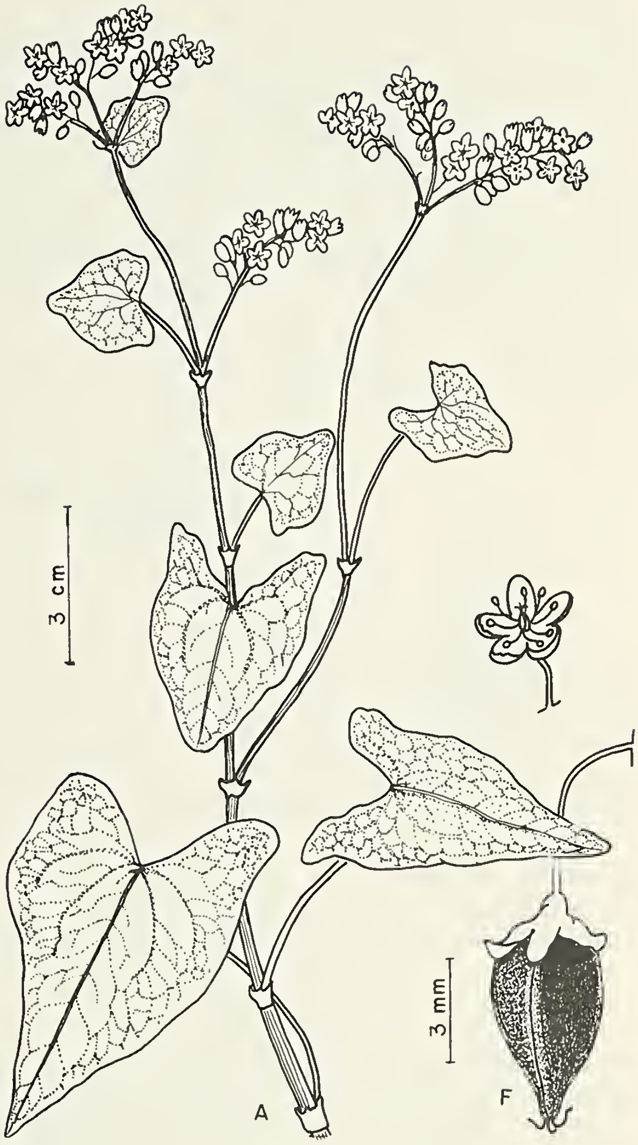
A Eurasian genus closely allied to *Polygonum* and of some economic importance. Two species are found in New York State as escapes from cultivation. They are usually not long persistent, but may appear naturalized for several years.

Description: Flowers bisexual; **stigmas** 3, capitate; **styles** 3, slender, free; **ovary** 3-lobed, unilocular with a single large orthotropous **ovule; placentation** basal, almost central; **fruit** a large, bluntly or sharply angled achene, pale brown to ebony, rough to shiny, exserted strongly from the unenlarged perianth; **seed** conforming to the fruit walls; **endosperm** copious, mealy; **embryo** large, dividing the endosperm, with large, much folded **cotyledons; stamens** 8; **perianth** petaloid, pale, equally 5-parted, not accrescent, persistent but wilting and drying; **pedicels** slender; **bracts** hemicylindric; **inflorescences** compound panicles borne laterally or simulating terminal corymbs; **leaves** hastate to sagittate, with substantial **petioles** below, much reduced upward; **stipules** hemicylindric, bristleless; **nodes** and **internodes** slender; stems ascending-erect, from an annual **taproot**.

KEY TO SPECIES OF FAGOPYRUM

1. Flowers creamy to white, 3–4 mm. long; achenes 5–7 mm. long; inflorescences corymb-like, clustered near the apex .... 1. *Fagopyrum sagittatum* (p. 59)
1. Flowers greenish, averaging 2–3 mm. long; achenes 5–5.5 mm. long; inflorescences raceme-like, more evenly distributed .... 2. *Fagopyrum tataricum* (p. 60)





1. Fagopyrum sagittatum Gilib.

Common Name: Buckwheat

Type Description: Gilibert, Excerc. Phyt. II, p. 435, 1792

Synonyms: *F. esculentum* Moench., *Polygonum fagopyrum* L.

Origin: Asian, cultivated in Europe and North America

Habitats: Disturbed ground, waste places, field margins

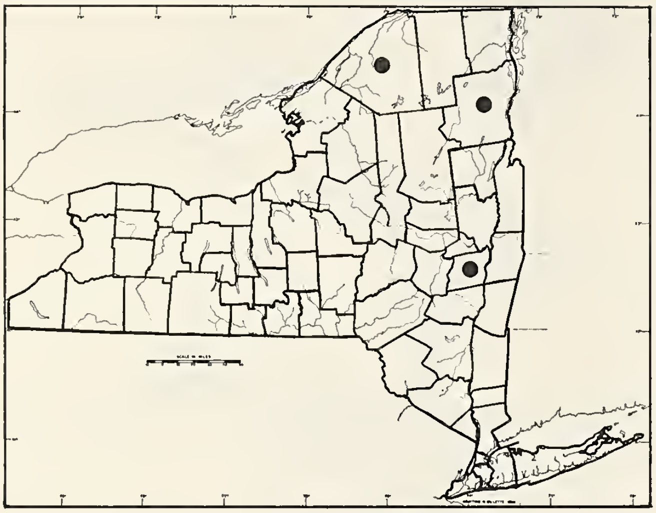
Habit: Erect to spreading annual

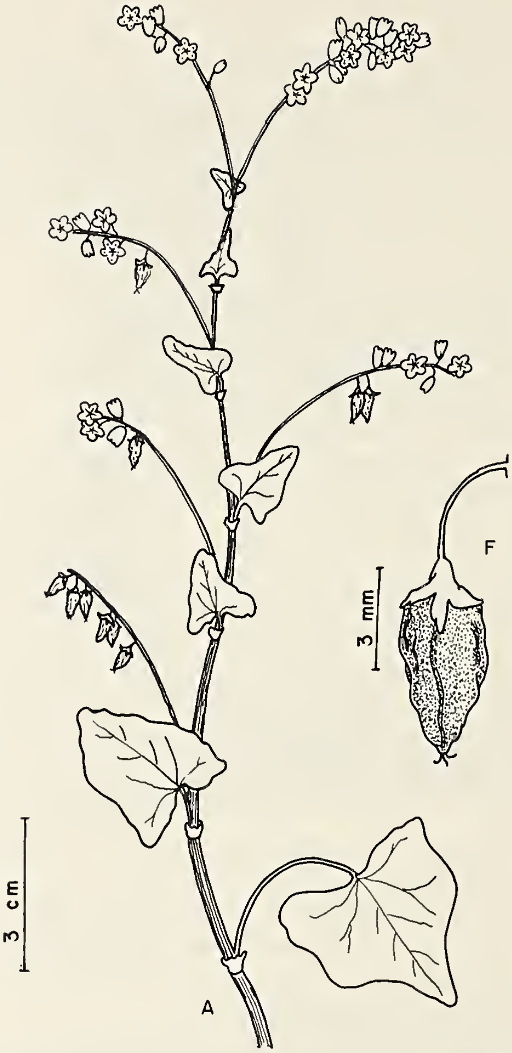
Flowering: June–August

General Distribution: Circumboreal escape, near sites of cultivation in cool climates

Description: Plants with bisexual flowers; **stigmas** 3, capitate; **styles** 3, free; **ovary** 3-angled, becoming a trigonous **achene;** achene 5–7 mm. long, shiny, dark brown, with rounded angles, much exserted when ripe; **stamens** 8: anther sacs reddish, about equal the perianth in length; **perianth** petaloid, 3–4 mm. long, 5-lobed to below the middle, creamy to white, streaked with tan, greenish only at very base, with a minute puberulence; **bracts** hemicylindric, sheathing, acute to apiculate, greenish with scarious ones within; **inflorescences** corymb-like panicles, concentrated toward the plant apex; **peduncles** with patches of puberulence; **leaves** triangular-hastate; long **petioles** near the base of the plant becoming much reduced with the leaves toward the apex; leaf **margins** and **veins** with minute hairs; **stipules** scarious, obliquely truncated, often split along one side, bristleless; **nodes** scarcely enlarged; **stem** tough, erect from an annual **taproot** (2n = 16).

Importance: Early cultivation in Nepal, China, Siberia, spread to Europe in the 16th century; ground up achenes make a flour used much like a cereal to make griddle cakes or a bread; United States production was once much higher; in 1880, fourteen and one half million bushels were produced, one third of which came from New York State; it is used as a cattle food, cover crop, mulching and forage for grazing animals; it may be brewed into a beer; it is cited as a honey plant and the leaves are a source of a brown (yellow) dye; unrefined, it is well known as a photosensitizer in cattle and humans (rare), and it has been implicated in human allergenic response; in folk medicine it was used to treat erysipelas and purported to return milk to nursing mothers.





2. *Fagopyrum tataricum* (L.) Gaertn.

Common Name: India Wheat
Type Description: Gaertner, Fruct. II, p. 182, 1791
Synonym: *Polygonum tataricum* L.
Origin: Asia, cultivated in Europe
Habitats: Waste places, disturbed ground, field margins (cultivated)
Habit: Erect annual
Flowering: June–September
General Distribution: Eurasia, North America as an escape

Description: Plants with bisexual flowers; **stigmas** 3, capitate; **styles** 3, free; **ovary** 1, becoming a 3-angled **achene**; achene 5–5.5 mm. long, dull, rough on the surfaces, sharply or irregularly margined, brown, exserted when ripe; **stamens** 8, about equal to the perianth; **perianth** 5-lobed to below the middle, 2–3 mm. long, greenish with slightly paler or rose-tinged lobes; **bracts** sheathing, scarious; **inflorescences** raceme-like panicles 2–5 cm. long, subevenly scattered throughout the plant; **peduncles** up to 6 cm. long, becoming shorter upward with the leaves, glabrous; **leaves** broadly hastate, puberulent on some veins and margins, (leaves) reduced upward; **petioles** up to 7 cm., reduced upward, puberulent to densely glandular; **stipules** tubular to lacerate, puberulent to glandular, without marginal bristles; **nodes** scarcely swollen; **stems** tough, erect, from an annual **taproot.**

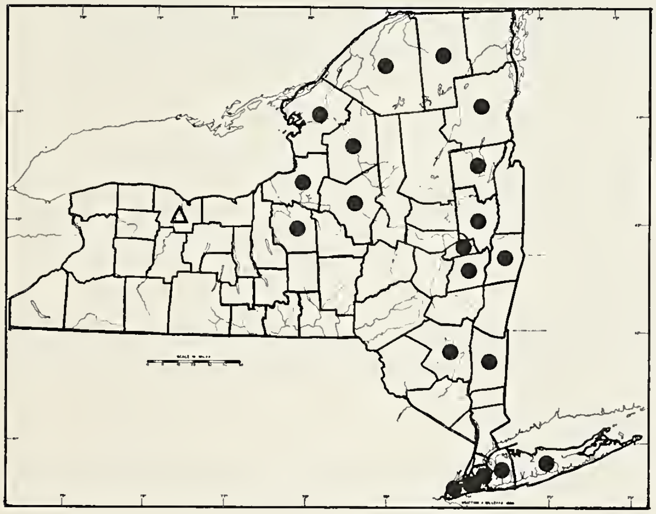
Importance: Far less widely cultivated than Buckwheat itself, but with many of the same attributes.

5. POLYGONELLA

Common Name: Jointweed

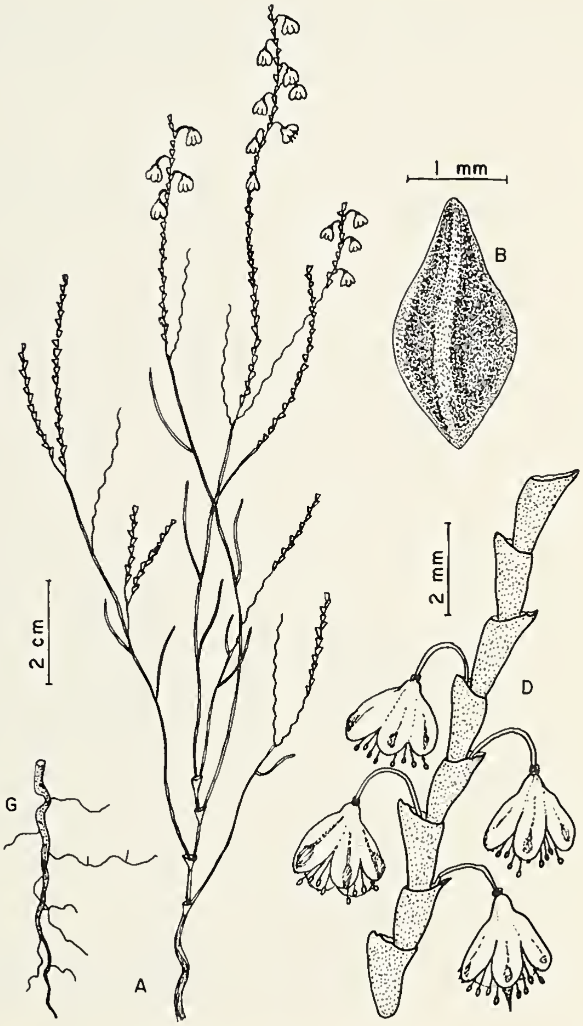
A genus of about nine species, native to the Eastern United States. Mostly indigenous to the Southern Coastal Plain, but with one species ranging northward, and another an endemic outlier in Texas. Represented in New York State by a single species.

Description: Flowers bisexual or functionally unisexual; **stigmas** 3, capitate; **styles** 3, separate; **ovary** unilocular, 3-angled, with a single orthotropous **ovule** in one of its angles; **placentation** basal; **fruit** an achene, 3-angled (rarely 2 or 4), acute to acuminate at apex, acuminate to truncate at base, gray, yellow or dark reddish-brown, glossy or minutely pebbled; **seed** conforming in shape to the achene in maturity; **embryo** straight or slightly curved; **endosperm** mealy; **stamens** 8, in series of 3 inner and 5 outer: filaments alike or the inner ones dilated, anther sacs white through red to dark purple, opening by 2 longitudinal slits; **perianth** petaloid, 3-lobed with 2 outer and 3 inner (or one of these transitional); **outer lobes** white, pink or red, glabrous, appressed, spreading or reflexed, margins entire (in ours) or erose; **inner lobes** similarly colored, glabrous, oblong with obtuse apices, entire (or erose to fimbriate), distinctly to slightly accrescent; **pedicels** jointed to unbranched peduncles, deflexed in fruit (in ours); **inflorescences** racemose (acropetal) with flowers borne singly from the axils of imbricated, tubular **bracts** (ocreolae), slender, often numerous; **leaves** alternate, glabrous (rarely scabrous) usually caducous (in ours), filiform (to obovate) the apex linearly acute (to obtuse), bases articulated, the joint occurring near the stipule summit; **stipules** tubular-cylindric, glabrous; **branches** adnate, diverging laterally well above the nodes; **internodes** fluted and striated, greenish to pink (with reddish bark in some); **stem** erect or prostrate from annual or perennial **taproots.**



1. Polygonella articulata (L.) Meisn.

Common Names: Jointweed, "Heather"
Type Description: Meisner, Gen. Comm. 2:228, 1836–43
Synonyms: *Delopyrum articulatum* (L.) Small, *Psammogonum articulatum* (L.) Niewl.
Origin: Native, Eastern United States
Habitats: Poor, often sandy soils; open, usually sunny sites
Habit: Erect, wiry, heath-like annuals
Flowering: August–November
General Distribution: Minnesota to Maine, south to North Carolina on the coast



Description: Plants with bisexual flowers or polygamous; **stigmas** 3, **styles** 3, free; **ovary** 1, becoming a 3-angled **achene**; achene, shiny, red-brown, slightly exserted at maturity, 2–2.8 mm. long; **stamens** 3, equaling the perianth or slightly exserted, inner filaments dilate at base; **perianth** with 5 subequal lobes, 1.4–2.5 mm. long, white to pink or rose (rarely purplish), the outer 3 with small green keels; **pedicels** up to 2.8 mm. long, recurved in fruit; **inflorescences** of slender, branched racemes 2–3.5 cm. long, with flowers borne singly from the axils of the sheathing bracts; **leaves linear,** early deciduous, glaucous, jointed at the base, 0.5–2.5 cm. long, 0.5–1.5 mm. wide; **stipules** tubular-cylindric, glabrous, acute, bristleless; **stems** wiry, green or red-tinged, slightly ribbed, glaucous, 8–50 cm. tall, erect (rarely prostrate) from a wiry, often coiled **taproot** (2n = 32).

Infraspecific Variation: Plants with dark, purple-red flowers have been referred to forma *atrorubens* Fern. Certain populations on Long Island occur in blowout areas of dunes and lie prostrate.

APPENDIX I

FUNGI ASSOCIATED WITH THE POLYGONACEAE OF NEW YORK STATE

To be included on this list, a fungus must (1) occur on a polygonaceous host whose distribution includes New York State; or (2) the fungus must have been collected in New York (not necessarily on a polygonaceous host) and be recorded as occurring on a genus of polygonaceous host which occurs in New York State. A single asterisk (*) indicates that this second set of conditions has been fulfilled.

Abbreviations of states indicate a literature citation for each state. Double asterisks (**) indicate that a herbarium specimen with New York State polygonaceous host information has been seen.

MYXOMYCETES (SLIME MOLDS)

Physarum polycephalum Schw. * on *Polygonum aviculare*

CHYTRIDIALES

Synchytrium anomalum Schroet. on leaves of *Rumex acetosa* (Iowa)
Urophlyctis major Schroet. on *Rumex verticillatus* (N. Dak., Wisc.) *Rumex orbiculatus***

SAPROLEGNIALES

Plectospira plagiocaula Drechsler on roots of *Rumex acetosella* (Md.)

PERONOSPORALES

Peronospora americana Gäum. on *Polygonum ramosissimum* (Ill., Nebr.)
Peronospora polygoni A. Fisch. on *Polygonum aviculare* (Iowa), *P. convolvulus*, *P. ramosissimum*, *P. scandens* (N.Y.), *P. scandens* var. *dumetorum* (N.Y.) *Rheum rhaponticum* (Cal.)
Phytophthora cactorum (Lebert and Cohn) Schroet. on *Rheum rhaponticum* (Pa., Mo., Okla., Cal.)
Phytophthora parasitica Dastur on *Fagopyrum sagittatum*, *Rheum rhaponticum***
Phytophthora terrestris Sherb. on *Rheum rhaponticum*
Pythium anandrum Drechsler on *Rheum rhaponticum* (Cal., Md.)
Pythium helicandrum Drechsler on *Rumex acetosella* (Md.)
Pythium irregulare Buis. on *Rheum rhaponticum* (Cal.)
Pythium oligandrum Drechsler on *Rheum rhaponticum* (Cal.)
Pythium splendens Braun on *Rheum rhaponticum* (Cal.)

ERYSIPHALES (POWDERY MILDEWS)

Erysiphe cichoracearum DC. ex Mér. on *Rumex altissimus*
Erysiphe polygoni DC. ex Mér. on *Fagopyrum sagittatum*, *Polygonum aviculare***, *P. buxiforme*, *P. erectum***, *P. convolvulus* (Ind.), *P. persicaria* (N.Y.), *P. ramosissimum*, *P. ramosissimum* forma *exertum*, *P. scandens*
Phyllactinia guttata (Fr.) Lév. (=*P. corylea* Pers. ex Karst) on *Polygonum virginianum* (Mich.)

DOTHIDEALES

Didymella exigua (Niessl) Sacc. on *Rumex acetosa*
Didymella lophospora (Ellis) Sacc. and Spreng.* on *Rumex acetosella*, *Rumex* sp.
Mycosphaerella polygonorum (Crié) Dearness and House (see *Depazea*, Sphaeropsidales)
Mycosphaerella tassiana (DeNot.) Johanson on *Rumex acetosella* [(perfect state of *Cladosporium herbarum* (Pers.) Link ex Fr.)]

SPHAERIALES

Diaporthe arctii (Lasch) Nits. * on dead stems of *Polygonum* sp., on dead stems of *Rumex crispus* (Ga.)
Diaporthe dakotensis Wehmeyer stems of *Polygonum amphibium* var. *emersum* (S. Dak.)
Gnomoniella curvicolla (Peck) Cooke on *Polygonella articulata***
Gnomoniella eccentrica (Cooke and Peck) Sacc. on *Polygonum amphibium***
Metasphaeria polygoni-sagittati (Schw.) Ellis and Everh. on *Polygonum sagittatum, Polygonum scandens*

HELOTIALES

Helotium rhizicola Seaver on *Polygonum virginianum* (N.Y.)
Hymenoscyphus scutulus (Pers. ex Fr.) Phill. on *Polygonum amphibium* var. *emersum*
Hymenoscyphus scutulus (Pers. ex Fr.) Phill. var. *fucata* Phill. on *Polygonum robustius*
Mollisia discolor (Mont.) Phill.* on *Polygonum pensylvanicum*
Mollisia polygoni (Lasch) Gill. on *Polygonum lapathifolium***, *P. persicaria* (N.J.)

PLEOSPORALES

Leptosphaeria fusispora Niessl on *Polygonum cuspidatum* (N.Y.)
Ophiobolus acuminatus (Sow.) ex Fr. on * *Polygonum* sp.
Physalospora obtusa (Schw.) Cooke on stems of *Polygonum* sp. (Ala., N.J.), *Rumex crispus* (Ga.), *R. obtusifolius* (Ga.)
Physalospora polygoni Ellis and Everh. on *Polygonum pensylvanicum* (Ala.)
Pleospora compressa Harkn. on *Polygonum amphibium* var. *emersum* (Cal.)
Venturia canadensis Barr on *Rumex acetosella* (Can.)
Venturia rumicis (Desm.) Winter on *Rumex crispus* (Wash.), *R. obtusifolius* (Ala., Wash.), *R. triangulivalvis*

UREDINALES (RUSTS)

Aecidium polygoni Chev. on *Polygonum aviculare*
Aecidium sommerfeltii Johanson on *Polygonum scandens*
Puccinia acetosae (Schum.) Koern. on *Rumex acetosa***, *R. acetosella***, *R. hastatulus* (Fla., Mass., S.C.), *R. persicariodes*; II, III on *Rumex*; O, I unknown
Puccinia aristidae Tracy on *Polygonum aviculare* (Colo., Del., N. Dak., S. Dak., Nebr.), *P. erectum* (Colo.), *P. ramosissimum* (Colo.); I on *Polygonum*; II, III on various grasses
Puccinia ornata Arth. and Holw. on *Rumex orbiculatus***
Puccinia parca Arth. on *Polygonum scandens* (N.Y.)
Puccinia phragmitis (Schum.) Koern.; O, I, on *Rheum rhaponticum* (Cal., Minn., Nebr.), *Rumex crispus* (Nebr.); Experimentally on *Polygonum convolvulus, P. lapathifolium, P. pensylvanicum, Rumex acetosa, R. altissimus, R. conglomeratus, R. longifolius, R. obtusifolius, R. orbiculatus, R. patientia, R. pulcher, R. triangulivalvis;* II, III on *Phragmites australis*
Puccinia polygoni-amphibii Pers. var *convolvuli* (Alb. and Schw.) Arth. on *Polygonella articulata* (Fla.), *Polygonum convolvulus***, *P. scandens***, *P. scandens* var. *cristatum* (Miss., N.C., Pa., Tex., Va.), *P. scandens* var. *dumetorum* (W. Va.); II, III on *Polygonella* and *Polygonum;* O, I not known in United States, on *Geranium* sp. in Europe
Puccinia polygoni-amphibii Pers. var. *persicariae* (Strauss) Arth. on *Polygonum amphibium***, *P. careyi, P. hydropiper* (S.C.), *P. hydropiperoides***, *P. lapathifolium***, *P. opelousanum***, *P. pensylvanicum***, *P. persicaria* (Del., Pa., Ga., La., Ore.), *P. punctatum***, *P. setaceum* (Ala., La., Mo.); II, III on *Polygonum;* I on *Geranium* sp.
Puccinia polygoni-amphibii Pers. var. *tovariae* Arth. on *Polygonum virginianum***, *P. pensylvanicum* (La.); II, III on *Polygonum;* O, I unknown
Puccinia punctiformis Diet. and Holw. (= *Puccinia lapathicola* Hylander, Jovst. and Nannfeldt) on *Rumex altissimus, R. crispus, R. triangulivalvis* (Kan., Tex., Wisc.)
Uromyces polygoni (Pers.) Arth. [(= *Uromyces polygoni-avicularis* (Pers.) Karst.)] on *Polygonum aviculare***, *P. buxiforme* (Cal., Colo.). *P. erectum***, *P. glaucum* (La., Mass.), *P. neglectum, P. ramosissimum* (Ill., Iowa, Kan., Minn., Mont., Nebr.), *P. setaceum*

USTILAGINALES (SMUTS)

Melanopsichium austro-americanum (Speg.) Beck on *Polygonum aviculare* (Cal.), *P. lapathifolium* (?)

Melanopsichium pennsylvanicum Hirsch. on *Polygonum lapathifolium***, *P. pensylvanicum*

Melanopsichium pennsylvanicum Hirsch. var. *besseyanum* Zundel on *Polygonum hydropiper* (N.Y.)

Melanopsichium pennsylvanicum Hirsch. var. *caulicolum* Zundel on *Polygonum aviculare* (N.Y.), *P. lapathifolium* (N.Y.)

Sphaceotheca hydropiperis (Schum.) deBary on *Polygonum hydropiper* (N.Y.), *P. hydropiperoides***, *P. persicaria* (N.Y.), *P. sagittatum***

Ustilago anomala J. Kunze on *Polygonum cilinode* (N.Y.), *P. convolvulus***, *P. hydropiper***, *P. pensylvanicum*, *P. punctatum***, *P. scandens*, *P. scandens* var. *dumetorum*

Ustilago anomala J. Kunze var. *tovarae* Savile on *Polygonum virginianum* (Que.)

Ustilago parlatorei Fisch. von Waldh. *Rumex acetosella* (S.C.), *R. altissimus* (Mo., Nebr.), *R. hastatulus* (Ala., Fla.), *R. orbiculatus* (Mo., Nebr.), *R. triangulivalvis* (Mo., Nebr.)

Ustilago rumicis (Berk.) Clinton (= *Ustilago parlatorei* Fisch. von Waldh.)

Ustilago tenuispora Cif. on *Polygonum punctatum*** (Fla.)

Ustilago utriculosa (Nees) Ung. on *Polygonum amphibium***, *P. aviculare* (Cal.), *P. careyi***, *P. erectum* (Miss.), *P. hydropiper*, *P. hydropiperoides***, *P. lapathifolium***, *P. pensylvanicum***, *P. persicaria***, *P. sagittatum*, *P. scandens***

APHYLLOPHORALES

Pellicularia filamentosa (Pat.) Rogers* on *Polygonum* sp. (Fla.)

Typhula intermedia Appel and Laubert on Buckwheat straw (N.Y.)

Typhula phacorrhiza Reichard ex Fr. on Buckwheat straw (N.Y.)

Typhula variabilis Riess on Buckwheat straw (N.Y.)

AGARICALES (MUSHROOMS)

Armillaria mellea Vahl ex Fr. Root rot on *Rheum rhaponticum*

Galerina sulcatipes (Berk.) Singer on *Fagopyrum sagittatum*

MONILIALES

Alternaria alternata (Fr.) Keiss. on *Fagopyrum sagittatum* (Iowa, Minn., Vt.)

Alternaria sp. *Rheum rhaponticum* (N.J., Pa.)

Botrytis cinerea Pers. ex Pers.* Gray Mold Rot on *Rheum rhaponticum*, occasional in the field, forcing culture and markets (Mich., Mo., Va., Wash.)

Botrytis fascicularis (Corda) Sacc. on *Polygonum* sp.**

Botrytis hypophylla Ellis and Kellerm. on *Polygonum hydropiper*

Cercospora acetosellae Ellis on *Rumex acetosa*** (Tex.), *Rumex acetosella* (La., N.C., N.J., Tex.)

Cercospora acetosellae Ellis var. *maculosa* Peck on *Rumex crispus***

Cercospora avicularis Wint. on *Polygonum aviculare***, *P. erectum*

Cercospora polygonacea Ellis and Everh. on *Polygonum aviculare* (N.Y.), *P. convolvulus*, *P. lapathifolium*, (Mont.), *P. ramosissimum* (Kan.), *P. sagittatum* (N.Y.), *P. scandens*, *P. scandens* var. *dumetorum*

Cercospora rhapontici Tehon and Daniels on *Rheum rhaponticum* (Ill., Del.?, Md.?, Nebr.?)

Cercospora rumicis Ellis and Langl. on *Rumex crispus* (Iowa), *R. obtusifolius* (La., Tex.)

Cladosporium herbarum (Pers.) Link ex Fr.* on *Rheum rhaponticum* (Cal., Wash.)

Coniosporium harknessioides (Ellis and Holw.) Sacc. on *Rumex acetosa*, *R. acetosella*

Didymaria effusa (Berk. and Curt.) Solheim (including *Cercospora hydropiperis* Thuem. and *Cercospora polygonorum* Cooke) on *Polygonum amphibium* var. *emersum*, *P. hydropiper***, *P. hydropiperoides***, *P. lapathifolium*, *P. pensylvanicum*, *P. persicaria*, *P. punctatum***, *P. sagittatum*

Fusarium sp. on *Rheum rhaponticum* (N.C., Okla., Wash.)

Ovularia avicularis Peck on *Polygonum aviculare*

Ovularia bistortae (Fuckel) Sacc. on *Polygonum erectum*

Ovularia monosporia (West) Pound and Clements [= *O. obliqua* (Cooke) Oud.] on *Rumex altissimus* (Tex.), *R. crispus***, *R. obtusifolius***, *R. orbiculatus*, *R. verticillatus*

Ovularia rigidula Delacr. on *Polygonum aviculare* (Nebr., Wisc.), *P. erectum* (Wisc.)

Periconia byssoides Pers. ex Merat* on *Rumex* sp.

Phymatotrichum omnivorum (Shear) Dug. on *Polygonum aviculare* (Tex.), *P. lapathifolium* (Tex.), *Polygonum* sp. (Tex.), *Rheum rhaponticum* (Ariz., Tex.), *Rumex crispus* (Tex.)

Ramularia anomala Peck on *Fagopyrum sagittatum* (Conn.), *Polygonum convolvulus* (Ind., Nebr., Wisc.), *P. scandens* (Ind., Nebr., Wisc.)

Ramularia cilinodis J. J. Davis on *Polygonum cilinode*** (Pa., Wisc.)

Ramularia circumfusa Ellis and Everh. on *Rumex obtusifolius* (Tex.)

Ramularia obovata Fuckel on *Rumex crispus***, *R. verticillatus***

Ramularia occidentalis Ellis and Kellerm. on *Rumex altissimus*, *R. orbiculatus***, *R. crispus*** (Ill., Iowa, La., Kans., Miss., Nebr., N.H., Wisc.)

Ramularia pratensis Sacc. on *Rumex orbiculatus* (Del., Md., Wisc.), *R. persicariodes* (Wisc.), *R. verticillatus* (Del., Md., Wisc.)

Ramularia rhei All. on *Rheum rhaponticum* (Cal.)

Ramularia rufomaculans Peck (= *Septocylindrium rufomaculans* (Peck) Pound and Clements), on *Fagopyrum sagittatum*, *Polygonum amphibium***, *P. aviculare* (Iowa), *P. cilinode***, *P. hydropiper* (N.Y.), *P. lapathifolium***, *P. persicaria* (N.Y.), *P. scandens*, *P. scandens* var. *dumetorum* (Iowa), *Polygonum* sp. (N.Y.)

Rhizoctonia solani Kuehn on *Fagopyrum sagittatum*, *Polygonum convolvulus* (Wash.), *Rheum rhaponticum* (N.Y.), *Rumex acetosa* (Tex.), *R. acetosella* (Tex.)

Spegazzinia rubra Dearness and House on *Polygonum scandens***

SPHAEROPSIDALES

Ascochyta biguttulata Daniels on *Polygonum convolvulus* (Ill.), *P. persicaria* (Okla.)

Ascochyta bresadolae Sacc. and Syd. on *Fagopyrum sagittatum* (Conn., Pa., Wisc.)

Ascochyta fagopyri Bres. on *Fagopyrum sagittatum* (N.Y.)

Ascochyta rhei Ellis and Everh. on *Rheum rhaponticum***

Darluca filum (Biv.) Cast. on *Polygonum amphibium*** on the sori of the rust, *Puccinia polygoni-amphibii*

Depazea polygonorum Crié [= *Mycosphaerella polygonorum* (Crié) Dearness and House] on *Polygonum amphibium* var. *emersum*

Diplodia polygonicula Peck on *Polygonum lapathifolium* (Kans.)

Macrophoma pulchrispora (Peck and G. W. Clinton) Sacc. on *Polygonum pensylvanicum* (N.Y.)

Macrophoma straminella (Bres.) Died. on *Rheum rhaponticum*

Phlyctaena complanata (Berk. and Curt.) Sacc. on *Polygonum virginianum***, *P. convolvulus*

Phoma demetriana Bubak on *Polygonum lapathifolium*

Phoma exigua Desm. on *Polygonum* sp. (N.Y.)

Phoma herbarum Westend. on *Rheum rhaponticum*, *Polygonum hydropiper*

Phyllosticta acetosellae A. L. Sm. and Ramsbottom on *Rumex acetosella* (Wisc.)

Phyllosticta circuligerens Tehon and Daniels on *Rumex altissimus* (Ill.)

Phyllosticta polygonorum Sacc. on *Fagopyrum sagittatum*, *Polygonum amphibium* (Wisc.), *Polygonum* sp. (Ill.)

Phyllosticta straminella Bres. on *Rheum rhaponticum*

Phyllosticta sp. on *Rumex acetosa* (N.Y.)

Rhabdospora polygoni Dearness and House on *Polygonum virginianum***

Septoria pleosporoides Sacc. on *Rumex acetosa* (Tex.), *R. acetosella* (Tex.)

Septoria polygonicola (Lasch) Sacc. on *Polygonum hydropiper*

Septoria polygonina Thuem. on *Polygonum cilinode***

Septoria polygonorum Desm. on *Polygonum amphibium* var. *emersum*, *P. aviculare* (Minn., Wisc.), *P. buxiforme*, (N.Y.), *P. cilinode* (Wisc.), *P. convolvulus*** (Wisc.), *P. erectum* (Minn., Wisc.), *P. hydropiper***, *P. lapathifolium*, *P. orientale*, *P. pensylvanicum***, *P. persicaria***, *P. scandens* (Vt.)

Septoria rhaponticae Thuem. on *Rheum rhaponticum* (Iowa)

Septoria rumicicola All. (*Septoria rumicis* Ellis) on *Rumex altissimus*, *R. orbiculatus*, *R. verticillatus*, *Rumex* sp. (N.Y.)

Septoria rumicis Trail (non Ellis) on *Rumex altissimus* (Wisc.), *R. triangulivalvis* (Ill., Kans., Nebr., Wyo.)

Sphaeropsis rumicicola Sacc. on dead stems of *Rumex* sp. (N.Y.)

Sphaeropsis sphaerelloides Ellis and Everh. on *Rumex crispus* (Ohio), *R. obtusifolius* (Ohio)

MELANCONIALES

Colletotrichum erumpens Sacc. on *Polygonum erectum*, *P. lapathifolium*, *Rheum rhaponticum* (Ill., Iowa, Mo., Okla., Pa., W. Va., Wisc.), *Rumex crispus*

Cylindrosporium pulchrum Speg. on *Rumex obtusifolius* (La.), *Rumex* sp. (Mo., S. Dak.)

Excipula rumicicola Sacc. on *Rumex verticillatus*

Gloeosporium polygoni Dearness and House on *Polygonum amphibium* var. *emersum***, *P. persicaria* (Mass.)

Gloeosporium rumicis Ellis and Everh. on *Rumex acetosa* (N.Y., Tex.), *R. acetosella* (Tex.), *R. obtusifolius* (Tex.)

Pestalotia polygoni Ellis and Everh. on *Polygonum virginianum*

Vermicularia dematium (Pers.) Fr.* on *Polygonum aviculare*

Vermicularia polygoni-virginici Schw. on *Polygonum amphibium* var. *emersum***, *P. virginianum*

Vermicularia rugulosa Ellis and Everh. on *Rumex crispus*

APPENDIX II

A List of Some Insects Associated with Polygonaceous Plants in New York State

HOMOPTERA

Cicadellidae

Empoasca fabae (Harris) Leaf Hopper on *Rheum rhaponticum*

Aphididae

Anuraphis roseus Baker on *Rumex*

Aphis armoraciae Cowen *Rumex obtusifolius*

Aphis fabae Scopoli *Fagopyrum sagittatum, F. tataricum, Polygonum aviculare, P. convolvulus, P. cuspidatum, P. persicaria, Rheum rhaponticum, Rumex crispus, R. longifolius, R. obtusifolius, R. patientia, R. verticillatus*

Aphis gossypii Glover *Rumex acetosella, R. crispus*

Aphis maidi-radicis Forbes Corn Root Aphid on Smartweeds (*Polygonum* sp.)

Aphis menthaeradicis Cowen *Rumex obtusifolius*

Aphis nasturtii Kaltenbach *Rumex obtusifolius*

Aphis rumexicolens Patch *Rumex* sp.

Aphis rumicis L. *Rumex acetosella, R. crispus, R. obtusifolius, R. patientia, R.verticillatus*

Aphis spiraecola Patch *Polygonum aviculare*

Aphis sp. *Rumex verticillatus*

Capitophorus braggii (Gillette) *Polygonum persicaria*

Capitophorus hippophoes (Walker) *Polygonum aviculare, P. pensylvanicum, P. persicaria, P. setaceum, P. virginianum*

Capitophorus hippophoes var. *javanicus* Hille Ris Lambers *Polygonum persicaria*

Dactynotus sp. *Rheum rhaponticum*

Forda formicaria Heyden *Polygonum* sp.

Macrosiphum euphorbiae (Thomas) *Polygonum hydropiper, P. scandens, Rheum rhaponticum, Rumex obtusifolius*

Macrosiphum venafuscae Davis *Polygonum convolvulus*

Myzus persicae (Sulzer) *Polygonum convolvulus, P. hydropiper, P. persicaria, Rheum rhaponticum, Rumex crispus, R. obtusifolius*

Pemphigus brevicornis Hart *Rumex crispus*

Prociphilus erigeronensis (Thomas) *Rumex obtusifolius*

Prociphilus sp. *Rheum rhaponticum*

Toxoptera graminum (Rondani) *Fagopyrum sagittatum*

HEMIPTERA

Miridae

Adelphocoris rapidus (Say) Breeds on Docks (*Rumex* sp.)

Deraeocoris histrio (Reuter) Breeds on *Polygonum amphibium* var. *emersum*

Garganus fusiformis (Say) on Smartweed (*Polygonum* sp.)

Lygus plagiatus Uhler Feeds on Smartweed (*Polygonum* sp.)

Poecilocapsus lineatus (Fabricius) Four Lined Plant Bug on *Rumex* sp.

COLEOPTERA

Chrysomelidae

Colaspis flavida (Say) Grape Colaspis on *Fagopyrum sagittatum*

Gastroidea cyanea Melsh. on *Rumex*

Gastroidea polygoni, L.

Pyrrhalta nymphaeae (L.) *Polygonum amphibium*

Systena hudsonias Forst. Smartweed Flea Beetle

- Curculionidae
  - *Acanthoscelis acephalus* Say on *Polygonum* sp. especially *Polygonum hydropiper*
  - *Acanthoscelis curtus* Say *Polygonum* in swamps
  - *Calandra oryzae* L. *Fagopyrum sagittatum*
  - *Ceutorhynchus neglectus* Blatchley *Polygonum* sp.
  - *Listronotus caudatus* Say *Polygonum hydropiperoides*
  - *Lixus concavus Say*, The Rhubard Curculio, *Rheum rhaponticum, Rumex crispus, R. obtusifolius, R. patientia*
  - *Lixus musculus* Say *Polygonum amphibium*
  - *Lixus rubellus* Rand. *Polygonum amphibium*
  - *Lixus terminalis* Lec. *Polygonum pensylvanicum*
  - *Pandeleteius hilaris* Hbst. *Polygonum* sp. (Smartweed)
  - *Pelenomus sulcicollis* Schön. on *Polygonum* sp. (Smartweed) in low ground
  - *Phytonomus comptus* Say *Polygonum* in wet places
  - *Rhinoncus longulus* Lec. on *Polygonum* sp.
  - *Rhinoncus pericarpius* Fab. on *Polygonum* sp.
  - *Rhinoncus pyrrhopus* Boh. common on *Polygonum pensylvanicum* and *Rumex*
  - *Tanymecus confertus* Gyll. on *Polygonum* sp. (Smartweed)

LEPIDOPTERA

- Coleophoridae
  - *Coleophora borea* Braun. *Polygonum scandens*
  - *Coleophora shaleriella* Chambers Seeds of *Polygonum punctatum*
- Gelechiidae
  - *Aristotelia absconditella* Walker Larvae in stems of *Polygonum* (Slight gall)
  - *Aristotelia minimella* Chambers
  - *Gelechia disccellella* Chambers Caterpiller on *Polygonum* sp. and *Rumex crispus*
- Tortricidae
  - *Cymolomia fasciatana* Clemens Larva on *Rumex*
- Pyralidae
  - *Pyrausta ainslei* Heinrich Larva boring in *Polygonum* in marshes
- Lycaenidae
  - *Lycaena epixanthe* (Boisduval and LeConte) *Polygonum persicaria, Polygonum* sp., *Rumex orbiculatus, R. patientia, R. verticillatus*
  - *Lycaena helloides* (Boisduval) *Polygonum amphibium, P. aviculare*
  - *Lycaena hyllus* (Cramer) *Polygonum* sp., *Rumex crispus, R. patientia*
  - *Lycaena hypophlaeas* (Boisduval) *Rumex acetosella, R. crispus*
  - *Strymon melinus* Hubner *Polygonum lapathifolium*
- Sphingidae
  - *Hyles lineata* (Fabricius) *Fagopyrum sagittatum, Polygonum* sp., *Rumex obtusifolius, Rumex* sp. (Sorrels)
- Arctiidae
  - *Apantesis arge* (Drury) *Polygonum* sp.
  - *Apantesis nais* Drury *Polygonum erectum, P. punctatum*
  - *Apantesis virguncula* (Kirby) *Polygonum aviculare*
  - *Diacrisia vagans* (Boisduval) *Rumex* sp. (Sorrels)
  - *Diacrisia virginica* (Fabricius) *Polygonum scandens, Polygonum* sp.
  - *Estigmene acrea* (Drury) Salt Marsh Caterpiller on *Polygonum amphibium*
  - *Isia isabella* Abbot and Smith Wooly Bear on *Polygonum persicaria*
- Noctuidae
  - *Acronicta oblinita* (Abbot and Smith) Smeared Dagger Moth *Fagopyrum sagittatum, Polygonum hydropiper, P. punctatum*
  - *Actebia fennica* (Tauscher) *Rumex crispus, Rumex* sp. (Sorrels)
  - *Agrotis ducens* Walker *Rumex crispus*

Agrotis gladiaria Morrison *Rumex crispus*
Amathes badinodis (Grote) *Rumex crispus*
Amathes c-nigrum (L.) *Rumex* sp. (Sorrels)
Amphipyra tragopoginis (L.) *Rumex* sp. (Sorrels)
Ceramica picta (Harris) Zebra Caterpiller *Fagopyrum sagittatum, Polygonum hydropiper*
Chorizagrotis auxiliaris (Grote) *Rheum rhaponticum*
Dipterygia scabriuscula (L.) *Rumex* sp. (Sorrels)
Erastria carneola (Guenee) *Polygonum persicaria, Rumex crispus, Rumex* sp. (Sorrels)
Euxoa messoria (Harris) Dark-sided Cutworm *Fagopyrum sagittatum*
Euxoa tessellata (Harris) Striped Cutworm *Fagopyrum sagittatum, Polygonum* sp., *Rheum rhaponticum, Rumex* sp. (Sorrels)
Faronta diffusa (Walker) *Polygonum convolvulus*
Feltia subterranea (Fabricius) *Polygonum aviculare*
Heliothis obsoleta Fabricius *Polygonum pensylvanicum, P. persicaria*
Lacinipolia renigera (Stephens) *Rumex crispus*
Laphygma frugiperda (Abbot and Smith) *Fagopyrum sagittatum*
Leuconycta lepidula (Grote) *Rumex* sp. (Sorrels)
Luperina passer (Guenee) Larvae in roots of *Rumex obtusifolius* and *R. verticillatus*
Nephelodes minians (Guenee) *Polygonum aviculare, P. hydropiper, Polygonum* sp.
Papaipema cataphracta (Grote) *Rheum rhaponticum*
Papaipema marginidens (Guenee) *Rumex* sp. (Sorrels)
Papaipema nebris (Guenee) *Polygonum hydropiper, Rheum rhaponticum, Rumex crispus, R. patientia*
Peridroma margaritosa (Haworth) Variegated Cutworm *Polygonum aviculare, Rheum rhaponticum, Rumex crispus*
Plathypena scabra (Fabricius) Green Clover Worm *Polygonum hydropiper, Polygonum* sp.
Prodenia eridania (Cramer) *Rheum rhaponticum, Rumex* sp. (Sorrels)
Prodenia ornithogalli Guenee *Rheum rhaponticum, Rumex* sp. (Sorrels)
Pyrrhia umbra Hufnagel *Polygonum pensylvanicum, P. persicaria*
Simyra henrici (Grote) *Polygonum hydropiper, P. lapathifolium*
Spaelotis clandestina Harris *Fagopyrum sagittatum*
Sunira bicolorago (Guenee) *Rumex crispus*
Trichoplusia ni (Hubner) *Rumex* sp. (Sorrels)

Liparidae
Liparis dispar (L.) Gypsy Moth *Rumex altissimus, R. crispus*

Geometridae
Apicia confusaria (Hubner) *Polygonum* sp.
Euphyia centrostrigaria (Wolloston) *Polygonum aviculare*
Euphyia multiferata (Walker) *Polygonum aviculare, P. hydropiper*
Haematopsis grataria (Fabricius) *Polygonum aviculare, P. hydropiper*
Melanolophia canadaria (Guenee) *Polygonum* sp.
Percnoptilota obstipata (Fabricius) *Polygonum hydropiper, P. persicaria, Polygonum* sp.
Scopula quinquelinearia (Packard) *Polygonum* sp.
Timandra amaturaria Walker *Polygonum scandens* var. *cristatum*
Xanthotype sospeta Drury *Polygonum hydropiper, Polygonum* sp.

Papilionidae
Papilio philenor (L.) *Polygonum convolvulus, P. scandens*

HYMENOPTERA

Lasius niger americanus Emery Cornfield Ant *Polygonum* sp. (Smartweeds)

PLANT GALLS

Contarinia rumicis Loew, Dock Seed Midge reared from deformed *Rumex* seeds
Lestodiplosis rumicis Felt, reared from same gall as above

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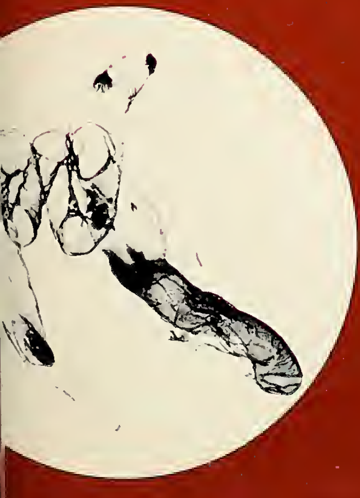
LEGEND

For all illustrations in this publication the following letter-designations apply:

A — Habit sketch
B — 3-angled achene
C — Lens-shaped achene
D — Partial inflorescence
E — Perianth enclosing achene
F — Perianth with exserted achene
G — Root
H — Achene transections
I — Leaf outline
J — Node
K — Petiole

For all maps in this publication the following symbols apply:

Solid dot ....specimen seen by author; data on file at the State Herbarium
Circle ....field observation with location data and observer's name of file
Hollow triangle...literature citation on file at the State Herbarium



A RECLASSIFICATION OF THE POLIA COMPLEX FOR NORTH AMERICA

(*Lepidoptera: Noctuidae*)

by Timothy L. McCabe

Curator of Entomology New York State Museum

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Albany, New York 12234

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Bulletin Number 432
NEW YORK STATE MUSEUM

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INTRODUCTION

This study is a review of the genus *Polia* (Noctuidae: Hadeninae) in the sense of McDunnough's 1938 list, which included *Polia* and "*Mamestra*" in the sense of Boursin, 1964. *Polia* Ochsenheimer was used as a catchall for numerous Hadeninae that agreed in superficial characters but that have proved on the basis of larval and genitalic characters to constitute discrete genera.

Polia sensu stricto (Heydemann, 1944) and the *Mamestra sensu* Boursin, 1964, do not form a continuous phylogenetic series; the Eurasian genus *Pachetra* is intermediate between *Polia* and *Mamestra sensu* Boursin. Furthermore, *Mamestra sensu stricto* consists only of moths with a tibial claw, and there are genitalic characters that can define the genus (e.g., absence of harpe). McDunnough's "*Polia*" contains *Polia* and the *Mamestra* of Boursin, but not *Mamestra sensu stricto*. Keys are provided to separate *Polia* from the genera included in *Mamestra sensu* Boursin, but neither *Mamestra sensu stricto* (with the tibial claw) nor the Palearctic *Pachetra* is included.

Included in McDunnough's "*Polia*" were species belonging to *Egira* Duponchel, *Lacinipolia* McDunnough, *Morrisonia* Grote, *Orthosia* Ochsenheimer, *Hexorthodes* McDunnough, the *Orthodes* complex, and some others of uncertain affinity. Most of these were placed by McDunnough at the end of his list of *Polia*, but he placed some with other species on the basis of superficial similarity. Accurate placement of many of these species would require a revision of the entire Hadeninae. Only the male genitalia of these species are figured, and the species are given only cursory treatment; they are not included in the keys. Non-*Polia* species described as *Polia* since McDunnough's list are discussed in the last section of this paper. In the species descriptions, only external adult characters that are of importance for establishing relationships, or are not apparent from the illustrations, are described because the adult habitus and genitalia of all species are illustrated.

The type series of many of the species described by Smith are now scattered among several museum collections. Dr. E. L. Todd of the Systematic Entomology Laboratories, United States Department of Agriculture at the United States National Museum has a forthcoming publication designating lectotypes for Smith species. Inasmuch as this paper is already in manuscript, I am not designating lectotypes for Smith's species. Through the courtesy of Dr. Todd, I have had prior knowledge of which specimens will be selected as type and have been able to examine them.

TERMS

The terminology employed for the habitus of the adults (this includes wing pattern) follows Forbes (1954). Forbes' terminology for the male genitalia is also followed, but with frequent use of terms employed by other authors where structures are involved that have not been covered by Forbes. Furthermore, some of Forbes' terms conflict with other author's usage. His "costal lobe of sacculus" is called the clavus (cl, fig. 14) by Pierce (1967) and Klots (1956). Forbes' clavus is found in *Lacanobia* species and I have referred to it as a "free clavus" to differentiate it from the clavus of Pierce and Klots. The free clavus (fc, fig. 53) has its origin on the membrane between the juxta and the sacculus.

Terms used for the aedeagal structures follow Pierce (1967). Female genitalic terminology follows Hodges (1971) except the corpus bursae is called the bursa (b, fig. 88) and the appendix bursae is called the appendix (apx, fig. 89) for the sake of brevity.

In addition to the above, I have used subscaphium (ssc, fig. 34) for the frequently sclerotized lower region of the anal tube (Hodges, 1971). I have also used Sukhareva's (1973) "costal process" (cp, fig. 37) when referring to *Melanchra* species and his "process of costa" (pc, fig. 72) when referring to *Papestra* species.

In *Polia*, it was necessary to refer to unnamed parts of the genitalia repeatedly. Rather than invent new names, I have used short descriptive phrases: Basal tuft of lower margin of valve (bt, fig. 14) for the tuft of fixed setae near the base of the lower margin of the valve; and apical tuft of the lower margin of valve (at, fig. 22) for the tuft of fixed setae near the apex of the lower margin of the valve. All genitalic terms mentioned in the text are identified in the figures. Because certain structures are restricted to one genus, the structures had to be identified in several figures. To aid in locating these figures, a page which lists all the terms and indicates where they can be located precedes the plates.

CLASSIFICATION

The generic name *Polia* has had a checkered history. The genus is now based on *Phalaena nebulosa* Hufnagel, 1766 (Berlin Mag. 3(4):418) by subsequent designation by Curtis, 1829 (Brit. Ent. 6:248), but cited as "*nebulosa* Och." an incorrect authorship. Apparently unaware of Curtis' work, Guenée selected *Phalaena nebulosa* as the genotype of *Aplecta* Guenée, 1838, by subsequent designation by Guenée, 1852 *in* Boisduval & Guenée, Hist. Nat. Insectes (Lepid.) 6:77. *Aplecta* is a junior objective synonym of *Polia* Ochsenheimer, 1816. *Polia* was used incorrectly by many authors with *Noctua flavicincta* Fab. as the type-species (Guenée, 1852, 6:32). In addition there is another incorrect type-species designation: *Noctua compta* [Denis & Schiffermüller], 1775. To quote from Nye (1975): ". . . a name not originally included in *Polia*, and not linked with one of the originally included names when cited by Duponchel, 1829 (March 21st), *in* Godart and Duponchel, Hist. Nat. Lepid, Papillons Fr. 7(2):71." Most of the species from the Neotropics placed in *Polia* do not belong to the genus; some are species of *Lacinipolia* and others are of uncertain placement.

Heydemann, (1944), placed 21 species in *Polia* in the Palearctic region. They range from Japan and northern Africa throughout the mountainous and northern parts of Eurasia. The nine Nearctic species of *Polia* range across Canada and the northern United States southward in the mountains to North Carolina and the southwestern states. Within a species, there is a tendency toward smaller size and duller pattern in the North and larger size and brighter pattern in the extreme West and Southwest and also in the Southeast. In the plates, I have frequently depicted the typical and extreme forms of a species, but I have made no attempt to illustrate the intermediate forms. Many endemic populations that add to the confusion in defining the species occur in the mountains in the West. Many of these populations have been named, several described as species: *P. mystica* Smith, *P. mysticoides* Barnes & Benjamin, *P. tufa* Smith, *P. juncimacula* Smith, *P. crydina* Dyar, *P. apurpura* Barnes & McDunnough, and still others. This reached its culmination in *P. purpurissata* Grote with the description of several populations as valid species.

Heydemann (1944) considered *Polia richardsoni* Curtis the most primitive species in the genus on the basis of the female bursa and the developmental history. *P. richardsoni* has a bursa that lacks bandlike signa (a derived condition) and has male genitalia with more marked asymmetry. The "entwicklungsgeschichtlich" of Heydemann may be a reference to Cope's Rule or, more likely, based on distribution. Holarctic distributions occur and may have come about in recent times as seems to be presently occurring with *Papestra biren* Goeze; in this last species possibly through human transport. *Polia nebulosa* Hufnagel and its relatives, on the other hand, have been separated long enough to have speciated in the two regions. If the rate of speciation in the two groups were similar, which is admittedly speculative, then *P. nebulosa* would reflect an older element on the basis of distribution. Furthermore, *P. nebulosa* has four bandlike signa, the ancestral state, whereas *P. richardsoni* lacks signa. *P. nebulosa*, in itself, is probably a derived state from an ancestor which had a more elaborate appendix and four fully fused bandlike signa. Fletcher (1972) has placed *P. bombycina* Hufnagel at the head of the series, indicating a primitive type. With this I concur.

It is likely that a *P. nebulosa*-like ancestral type invaded the west coast of North America and spread eastward and southward. Subsequent cooling in the northern hemisphere may have kept these populations separated thereby producing *Polia piniae* Buckett & Bauer and *P. discalis* Grote on the west coast and P. *nimbosa* Guenée on the east coast. This indicates a Palearctic origin of the genus *Polia*. The *purpurissata* group probably entered the Nearctic in the same manner and represents a phylogenetic line from a *bombycina*-like ancestral type. Based on *P. nebulosa* distribution, it seems likely that the epicenter for *Polia* evolution was the Palearctic, perhaps even Heydemann's (1944) "Mediterranean West-Gruppe."

Heydemann considered the Palearctic *Pachetra sagittigera* Hufnagel to be a primitive element of his "Mediterranean West-Gruppe." He also thought it was little more than a *Polia* and wasn't worthy of generic rank. Fletcher (1972) has maintained its rank as a monotypic genus. *Pachetra sagittigera* has a peculiar spined juxta and an unusually long band of cornuti. Also, *P. sagittigera* lacks the strengthening arch (sa, fig. 15) on the vesica so characteristic of *Polia*. *Pachetra* is intermediate between *Melanchra* and *Polia* and this connection will be discussed later.

North American *Polia* are divisible into two groups: *P. discalis* and its relatives (*nebulosa* group) and *P. purpurissata* and its relatives (*bombycina* group). The two groups can be characterized by the presence of a basal tuft (bt, fig. 14) on the lower margin of the valve together with a long "neck" leading to the cucullus (*nebulosa* group) as opposed to the presence of an apical tuft (at, fig. 22) on the lower margin of the valve combined with a short "neck" (*bombycina* group).

The main features of Heydemann's definition of *Polia* are: long, bent valves; presence of coronal spines, anal spines, and an ampullae; asymmetrical ventral arms; and a drawn-out blunt vesica armed with cornuti in the form of a band of spines. The females have a withdrawn ovipositor, weakly emarginate ventral plates, and a bursa with or without three weak, but prominent, short bandlike signa.

Heydemann's definition of *Polia* applies equally to our species, but can be refined in light of the present review of the Nearctic species. *P. piniae, P. imbrifera,* and *P. nimbosa* have four bandlike signa. Also, the anal spines (asp, fig. 14) may be one or two on each cucullus. The females are characterized by an upward (to the left) protruding lobe, bearing the ductus seminalis. I believe this lobe is a rudimentary appendix (apx, fig. 89). The primitive position of the ductus seminalis (ds, fig. 888) is believed to be at the posterior apex of the bursa. Within a genus of the Hadeninae (*Persectania* Hampson), the ductus seminalis occurs in an anterior or posterior position or some in between (Common, 1954). *Polia, Lacanobia,* and related genera are very consistent in the position of the ductus seminalis; it always originates from the tip of the appendix.

Females of *Polia* can be distinguished from related genera that also possess a lateral (left) development of the bursa (appendix) by the strengthening of the bursal wall at the base of the appendix and at the origin of the ductus bursae (db, fig. 88). *Anarta* Ochsenheimer, which some *Polia* superficially resemble, have a uniform, rather weakly sclerotized bursa.

The appendix arises from the posterior left portion of the bursa in Nearctic species of *Polia,* including the Holarctic *P. richardsoni*, and it is always a simple, short lobe. The Palearctic *Polia* are much more variable in form of the appendix; *P. hepatica* Clerck has a very large, curving appendix and *P. bombycina* Hufnagel has the appendix originating from a constriction of the bursa where the bursa joins the ductus bursae. This variability represents an older element of *Polia* in the Palearctic. Also, Nearctic *Polia* have had a reduction of the coremata (cta, fig. 196) (Heydemann's dufthaarapparat). Our species range from those with no coremata (*P. nimbosa*) to those with well-developed coremata (*P. discalis*). *P. nimbosa* has been considered a race of *nebulosa* (Heydemann, 1944), but *nebulosa* lacks coremata which are present in *P. nimbosa*.

Finally, there is a group of genera that stand in the McDunnough (1938) list as *Polia*, but in Europe they were treated as *Mamestra* by Boursin (1964), and as *Melanchra, Lacanobia,* and *Ceramica* by Fletcher (1972). The North American species are found to compose five genera, two of which are described as new. Generic limits are set according to adult genitalic structures (especially females) and larval characters and habits. A classification according to external adult characters, used in the past, led to an unnatural grouping based largely on adaptive characters (e.g., fore tibia unarmed, lashes absent, spines of fore tarsus not enlarged, and front not projecting).

My basis for distinguishing genera consists of making the limits where no link (other than regression or adaptive characters that are subject to convergence) can be established between species groups with any degree of certainty. Any attempt at placing species in a phylogenetic series is conjecture to begin with as fossil evidence is lacking. A division seems appropriate when it is necessary to reflect back on characters found in ancestral types, or supposed ancestral types, rather than direct comparisons with related species groups.

If a good fossil record existed we would expect almost all genera to flow gradually into one another on a continuum. However, because of extinction and isolating mechanisms, this ideal seldom occurs. When erecting genera, taxonomists look for a gap in the continuum and compare this gap to similar discontinuities in related groups (i.e., other genera in the family or subfamily when the number of species are sufficient for comparisons). When the number of species in a "uniform" genus is great, use of subgeneric or "species group" names refines the grouping and eases the burden of identification.

The subgenus has been used extensively by Sukhareva (1973), and I accept the concept of subgenera but differ with Sukhareva in the level to which he employed it. Most of Sukhareva's subgenera in "*Mamestra*" I have treated as genera. In my philosophy on the genus, I consider a subgenus to be composed of species groups which are clearly closely related, but still can be clumped in a statistical sense. American entomologists have used "species groups" where they have wished to avoid increasing the number of subgeneric names that subsequently must be considered within the Rules of Zoological Nomenclature on equal footing with the genus.

Almost all of the genera treated in this paper can be divided into subgenera or "species groups." As examples: in *Papestra* Sukhareva, we have females with a two-pronged subgenital plate (*P. cristifera* group) and those with a truncate subgenital plate (*P. quadrata* group); in *Trichordestra*, we have those with a narrow cucullus and possessing coremata as opposed to those with a wide cucullus and lacking coremata; in *Melanchra*, we have a division into at least two types of larvae, those with chevrons and those with stripes. These appear to be natural divisions. The genera involved are so small (largest contains only 29 species) and the species groups so closely related that a division into subgenera does not seem necessary to elucidate the classification.

Mayr (1969) defines a subspecies as: "A geographically defined aggregate of local populations which differs taxonomically from other such subdivisions of a species." Many subspecific names of North American Lepidoptera have not been applied in this sense. Many of the characters stressed represent ends of clines. With widely distributed species on a continent, virtually all nonmigratory members show gradual differences across their range. Mayr goes on to say: ". . . when the geographical variation is clinal, it is usually inadvisable to recognize subspecies, except possibly for the two opposite ends of the cline when they are very different or separated by a pronounced step." Subspecific names identifying the ends of a cline are treated solely because they exist in the literature. Most have been treated as straight synonyms. However, in two cases, that of *Polia purpurissata apurpura* Barnes & McDunnough and *Polia richardsoni magna* Barnes & Benjamin, I feel the subspecific category for these fits Mayr's definition. Even in the case of *P. p. apurpura*, increased collecting may prove it to be "step" clinal in nature. Mountain ranges, high peaks and desert areas in the West provide the best possibilities for isolating populations in North America. Food races and brood races are not well documented and often prove to be two species in the first case. My usage of race and subspecies is synonymous.

Characters which I consider ancestral are those which show up repeatedly in distantly related species throughout the Hadeninae and other Trifids (e.g., W-mark and coremata in the *Polia* complex, four bandlike signa, cornuti of aedaegus consisting of a cluster of spines). Most species show an intermingling of primitive and derived characters adding to the burden of constructing a meaningful classification. In the primitive genera, the characters tend to be more plastic or given to greater variation than in the advanced genera where the tendency is to greater uniformity in a given character. For example, antennae in *Polia* vary from filiform to serrate; the antennae are filiform in the related genera; signa vary from none to four bands in *Polia*; in the others the signa are fixed, consisting of three or four bands. It should not be construed that four bands and filiform antennae are always derived conditions because four bands appear to be an ancestral state. The lack of variability and the fixation on a character represents an apparent reduction in the gene pool through the processes of speciation.

The species of the various related genera show several derived states when compared to the more primitive species of *Polia*: reductions in degree of genitalic asymmetry, stabilized antennal condition, signa fixed at three or four bands and consistent within a genus. Table 1 gives a synopsis of characters useful at the generic and specific level. Tietz (1944) considered *Mamestra sensu stricto* more primitive than *Polia*. Apparently, he gave great weight to the tibial claw, which is an adaptive character. Genitalic characters such as the loss of signa in females and loss of appendages on the valves in males indicate a derived state.

Fletcher, 1972, has treated *Mamestra* in the restricted sense. Most of the species previously placed in *Mamestra* were than placed in the genus *Lacanobia* whose genotype is *w-latinum* Hufnagel. *Lacanobia w-latinum* is a species whose habitus is reminiscent of our *L. subjuncta*. *L. w-latinum* has the vesica with a distal strengthening arch on one fork, unlike anything else in the genus. The other fork is blind, terminating with a bulbed cornutus. In *L. w-latinum*, a long, broad lobe is developed from the central part of the sacculus instead of the claval area. The female was not examined, but Pierce figured it (pl. 11, fig. 3) and shows the bursa with four bands and an appendix from the left side. The female genitalia and the adult habitus clearly relate it to *L. subjuncta* and its relatives. All *Lacanobia* have the appendix arising on the left and also directed to the left.

The female genitalia give the clearest picture of the divisions between the genera. In *Trichordestra* gen. nov., the number of signa has become fixed at three complete bands, whereas, in *Papestra*, the bursa is apparently lost and its function is assumed by the appendix. This loss may have followed a condition seen in *Spiramater* gen. nov. where the appendix becomes longer and larger than the bursa and has apparently taken over much of the function of the bursa. This complete loss poses problems in determining the true relationships of *Papestra*. Characters of the male vesica in *Papestra* show little relation to those of *Spiramater*; the vesica and type of valve of *Papestra* seem to indicate a vague relationship with *Trichordestra*. These species indicate that three valid genera are involved.

In the phylogenetic scheme presented (Table 1), the genera *Trichordestra* and *Papestra* prove diffieult to relate to the other genera because there are considerable differences from the possible *Lacanobia*-like ancestral type; each may have arisen separately from a *Polia*-like ancestral type. I have grouped them together on the basis of male genitalic structure. They share weakened costal margins, compared to *Lacanobia*, and have a "process of the costa." The actual relation to each other or to the remaining genera is speculative. The remaining genera, *Melanchra*, *Spiramater*, and *Lacanobia* all have four bandlike signa, but differ from each other in the manner of development of the appendix.

Melanchra is probably derived from a *Polia*-like ancestor similar to *Pachetra*, a Eurasian genus intermediate in many ways between *Polia* and *Melanchra*, which gives us a view of an extant transitional type. The characters shared by *Pachetra* and *Polia* include an anal spine (asp, fig. 14) and an ampulla (am, fig. 13), but the ampullae have become weakly sclerotized. The female genitalia illustrated by Pierce (1942, pl. 5, fig. 11) have broadened, heavily chitinized ductus bursa (db, fig. 88) which is so characteristic of *Melanchra* species. The four weakened bandlike signa (bb, fig. 89) are reminiscent of the condition of *M. adjuncta* Boisduval and Eurasian *M. persicariae* L.

Melanchra has been treated as a synonym of *Mamestra* by Boursin (1965), Dufay (1975), and Forbes (1954), and the Nearctic species belonging in the genus were placed in *Polia* by McDunnough (1938). Fletcher (1972) treated it as a genus in its own right although he divided its species among *Ceramica* and *Melanchra*. Sukhareva (1973) apparently did not consider *Melanchra*, though if species placed in the genus are run through his keys they would key to *Lacanobia*. There are four species of *Melanchra* in North America: *M. picta; M. adjuncta*, which is closely related to the Eurasian *M. persicariae*; and *M. pulverulenta* and *M. assimilis*, which are closely related to the Eurasian *M. pisi* L. (*Ceramica pisi* of Fletcher, *Mamestra pisi* of Boursin).

Melanchra is characterized by the aedeagus terminating in a projection, by the tubular, strengthened costa terminating in an inwardly directed lobe, and by the development of the subscaphium, most prominent in *M. adjuncta* and *M. persicariae*. *Melanchra adjuncta* and *M. persicariae* have larvae which possess a caudal hump and chevron markings on the dorsum whereas the remaining species of *Melanchra* have larvae which are conspicuously striped. The markings of the larvae of *M. adjuncta* and *M. persicariae* are probably cryptic. *Melanchra adjuncta* larvae commonly rest curled up on a flower cluster or in dense foliage. The pattern of the conspicuously striped type of larvae is also adaptive, the striped pattern being disruptive when a caterpillar rests parallel to a stem. The striped larvae frequently rest with the head hidden in a leaf axil to further disrupt the predator's image of a caterpillar.

First instar larvae shed little light on the classification at the generic level. They show reduced abdominal prolegs on abdominal segments three and four and well-developed prolegs on segments five and six. This condition is found in the Hadenines, Agrotines, Amphypyrines and still others. The first instar larvae share the presence of the prothoracic SD-2 (Hinton system) and one subventral (SV) seta on the mesothoracic segment. Development of the prothoracic shield varies. *P. nimbosa* first instar larvae have well-developed, heavily sclerotized prothoracic shields. *Polia purpurissata*, in the other species group, have a very weakly sclerotized prothoracic shield. *Trichordestra legitima* and its relatives have a prothoracic shield that is only weakly sclerotized. The species of *Melanchra* have a very weakly sclerotized prothoracic shield. The prothoracic shield appears weak or strong repeatedly in Hadenine genera, but the state of development is usually consistent within a genus except in the primitive genera. I was able to examine first instars in only a few species of each genus, but none in *Papestra*, so there may be exceptions.

CHARACTERS USED

FEMALE BURSA. The bursa (b, fig. 88) has proved to be of high value for generic diagnosis. It is a comparatively simple structure with varying arrangements of signa (sg, fig. 87 and bb, fig. 89) and differing origins and development of the appendices (apx., fig. 89). Phylogenetic inferences are outlined in the female genitalia key.

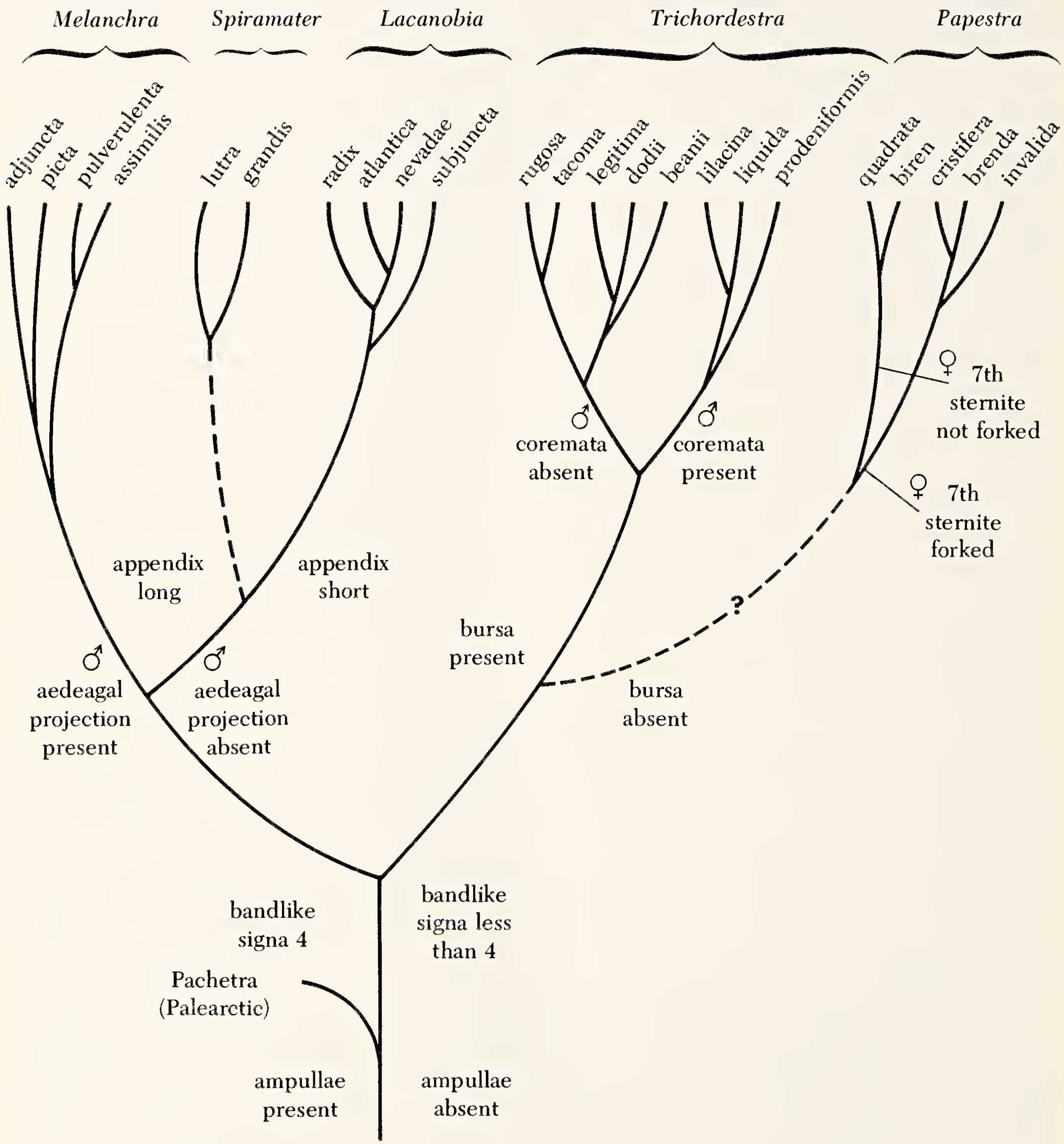
MALE VALVES. These structures are extremely modified and complicated providing excellent specific and generic characters, though the modification may cause confusion in interpreting the relationships. The strengthened costa (ca, fig. 37) as well as projections of the costa (di, fig. 53; pc, fig. 72; cp, fig. 37) have proved to be important in relating males to one another.

MALE AEDEAGUS. The number and arrangement of cornuti (cor, fig. 11) and the configuration of the vesica (ve, fig. 15) have proved useful at the generic and specific rank in all groups. The vesica in *Polia* is relatively simple, and the cornuti are of a basic form considered ancestral in many Hadeninae. Bulbed cornuti (bc, fig. 42) appear to be restricted to *Lacanobia* and *Spiramater* in this complex. An aedeagal projection (as, fig. 35) is characteristic of *Melanchra*.

ABDOMINAL TUFTING. Tufts are present in about half the species, and their arrangement and form are consistent at the "species group" level. Tufts may be present or absent throughout the Noctuidae and are of questionable importance in diagnosing genera. This is another example wherein a primitive genus may show great variability (from no tufts, to a basal tuft, to a full complement of tufts) and a derived genus has a fixed condition; i.e., absence of tufts, or a basal tuft only, or a full complement.

COREMATA. Male basal abdominal coremata (eta, fig. 196) are a trifid Noctuid feature (best developed in the subfamilies Amphypyrinae and Hadeninae). In Nearctic *Polia*, coremata exist in all states of development. They are present in all Palearctic *Polia* except *P. bombycina* Hufnagel (= *advena* Denis & Schiffermüller)(Heydemann,

Table 1. Relationships of the species of the genera other than *Polia*



1944). Aplin and Birch (1968) found 2-phenyl ethanol to be the principle chemical associated with the coremata in *Polia nebulosa* and *Melanchra adjuncta*. Coremata are useful for detecting trends, but the chemistry of the secretion has not been studied to the point where it can be used in a systematic way. The coremata are used in courtship and communicate visual as well as chemical cues to the female.

TARSAL SPINING. Throughout the complex, the spining consists of three rows of spines on the second, third, and fourth tarsal segments. Spination is useful for separating non-*Polia* Hadenines from the *Polia* complex; e.g., "*Polia*" *purpurea* Barnes & McDunnough was really an *Egira* Duponchel (= *Xylomyges* Guenée) as its four rows of spines attest.

WING PATTERN. This is frequently useful at the species level, but all groups show much the same basic noctuoid pattern. Presence of basal and medial dashes proved very useful in keys to the adults based upon the maculation. A darkened lower half of the reniform seems important and the presence or absence of the W-mark in the subterminal line is also significant. Terminology follows Forbes (1954).

VENATION. Virtually all members in the complex have the same pattern of veins. The variation between points of origin of the branches of veins among the genera is no more than what is frequently found within a species. *Melanchra* has a reduction in the strength of M_2 of the hindwing. This is also evident in *Polia imbrifera* Gn.

SUBGENITAL (SEVENTH STERNITE) PLATE OF FEMALE. In one genus, *Papestra*, this sternite (figs. 119–123) is more diagnostic than the standard genitalic characters. It can be examined without preparing the genitalia. The seventh sternite is frequently deeply cleft, a character Sukhareva (1973) used in addition to male genitalic structures to help define *Mamestra* in the broad sense.

MALE GENITALIA. A vast array of characters useful for separating genera and species are present. They provide clear-cut differences in many cases. Some of these include: presence or absence of bulbed cornuti, presence or absence of ampulla, presence or absence of the anal spine on cucullus, and presence or absence of a corona (marginal band of spines on the cucullus).

FEMALE GENITALIA. The simpler structure of the females limits the number of characters available, but the structures present are of utmost importance. Location and orientation of the appendix, number and location of signa, degree of sclerotization of the ductus bursa, and point of origin of the ductus seminalis (ds, fig. 88) all proved to be valuable for establishing generic relationships.

TECHNIQUES

Methods for preparing genitalia have been published previously (see Hardwick, 1950, and his bibliography), but enough particulars have been added than an outline is warranted.

Preparation of genitalia: the entire abdomen is removed at the base and placed in a 10% KOH solution for 8–12 hours at room temperature. After macerating, the abdomen is transferred to a syracuse watch glass of water and the integument is cut along the left pleural membrane with a fine scissors. The cut is initiated at the base of the abdomen. The genitalia are carefully teased away from the "pelt." In the case of females, careful manipulation with two pairs of watchmaker's forceps is required to remove the subgenital plate from the genitalia. In many groups of moths (e.g., Arctiidae and some Noctuidae) it is customary to leave the subgenital plate attached to the genitalia as the fusion is complete and removal is impossible without tearing. In the species involved in this study, the two plates separate readily except in two species. In these two cases they were carefully pulled apart for the sake of uniformity. After separation, the parts are allowed to remain in water for at least a half hour. This is done prior to brushing off the scales; otherwise the KOH residue will gradually dissolve the hairs of the brush.

After soaking, the male aedeagus is carefully removed, leaving the juxta and transtilla in position. The aedeagus remains in water, and the rest of the genitalia are placed in 70% alcohol and cleaned with a fine camel's hair brush to remove excess hair and scales. It is desirable to remove all hairs that are loosely attached or are likely to detach when the genitalia are finally put into balsam. Experience dictates which hairs must be removed. After the hairs and loose tissue are removed from the valves, they can be re-macerated for 30 seconds in hot KOH to "freshen" their appearance. This is usually unnecessary, but sometimes desirable. The genitalia are then transferred to water to soak (if from potash) or directly to 95% ethanol to dehydrate. In the ethanol, a square chip of glass (cut to various sizes from microscope slides) is placed on top to open and flatten the valves. Manipulation of the parts will insure uniform results.

Next, the pelt (tergites and sternites) is transferred to 70% ethanol and the scales are brushed off. The pelt is stained (see below) and moved to 95% ethanol, flattened by a chip of glass, and left to dehydrate.

The aedeagus (left in water) must have its vesica everted to appreciate the complexity and configuration of the associated lobes and cornuti. In many groups (e.g., microlepidoptera, butterflies, some small noctuids) the

Table 2. Character distribution among the genera

	Polia	Melanchra	Spiramater	Lacanobia	Trichordestra	Papestra
Coremati present (+); absent (−)	+ −	+ −	−	−	+ −	+
Peniculus present (+); absent (−)	+ −	−	+	+	+	+
Anal spine present (+); absent (−)	+	−	−	−	−	−
Abdominal tufts present (+); absent (−)	+ −	+ −	+	+ −	−	+
Bursa present (+); absent (−)	+	+	+	+	+	−
Bursal bands (signa 0, 1, 2, 3, or 4)	0–4	4	4	4	3	0
Appendix left (+); right (−); absent (0)	−	+	+	−	−	0
Digitus present (+); absent (−)	+	−	+ −	+	+	?
Strengthening arch* present (+); absent (−)	+	−	−	−	−	−
Ampullae present (+); absent (−)	+	−	−	−	−	−
Bulbed cornuti present (+); absent (−)	−	−	+	+ −	−	−
Aedeagal "spur" present (+); absent (−)	−	+	−	−	−	−
Lower half of reniform dark (+); light (−)	−	−	+ −	+	+	−
Clavi asymmetrical (+); symmetrical (−)	−	−	−	−	−	+
Subscaphium sclerotized (+); normal (−)	−	+ −	−	−	−	−
Free clavus present (+); absent (−)	−	−	−	+	−	−
Valve costa strengthened (+); normal (−)	−	+	+	+	−	−
Process of costa present (+); absent (−)	−	−	−	+	+	+
W-mark present (+); absent (−)	+ −	+	+	+	+	+ −
M2 (hindwing) reduced (+); normal (−)	+ −	+ −	−	−	−	−
♂ antennae simple (+); serrate (−)	+ −	−	−	−	−	−
♀ 7th sternite cleft (+); entire (−)	+ −	+	+	+	+	+
Cucullus present (+); absent (−)	+	+	+	+ −	+	+

* Refers to short, sclerotized band on the ♂ vesica.

aedeagus is too small to allow for eversion. A needle with a very fine pore is incapable of producing the pressure needed for eversion, making less than a 30-gauge hypodermic needle ineffective. Fortunately, all of the species involved in this study had vesicae that were eversible, although this is difficult in some species with elaborate vesicae or long cornuti (e.g., *grandis*, *lilacina*). To prepare the aedeagus for eversion of the vesicae, a 3×0 insect pin, with the point filed off and rounded, is inserted into the base and the vesica is gently pushed forward until enough space is available for insertion of a hypodermic needle, then water is forced into the aedeagus while a forceps holds the aedeagus on the hypodermic needle. All this is done while the aedeagus is under water. Usually the vesica readily everts, but in difficult cases it may be necessary to repeat the process with the 3×0 pin. Another 3×0 pin with a "hook tip" can be used to tease out the vesica. A combination of pushing and pulling the vesica and forcing water into the aedeagus is sometimes necessary.

After eversion, the aedeagus and the pelt are placed in the stain. Characteristics of the stain will be discussed after the special techniques for the females are covered. The valves need not go into the stain unless they are very light (weakly sclerotized or have been over-potashed).

Most wild-caught females will have mated and have spermatophores in the bursa. The presence of spermatophores may distort the natural shape of the bursa. To remove the spermatophores, it is necessary to remacerate the bursa for one or two minutes or longer in hot KOH. The treated bursa is then returned to water for five minutes. Spermatophores break down readily in potash and will generally dissolve in water after one treatment. On occasion this technique has to be repeated two or three times. After the spermatophores have dissolved, the loose tissues can be blown out of the bursa with a hypodermic needle and the entire genitalia can be placed in the stain. Upon removal from the stain, the bursa can be fully inflated with a hypodermic syringe filled with 95% ethanol.

STAINING: The Mercurochrome stain (1 gram Mercurochrome crystals to 150 cc of water) has proved to be a versatile, permanent stain. If the genitalia are accidentally overstained, the stain can be readily removed in a few seconds in Clorox. I have accidentally left a vesica in the stain overnight and it was not overstained. Usually 5–15 minutes is long enough to get good staining.

After a minimum of 24 hours in 95% ethanol, the stained and unstained structures can be moved into oil of cloves for one hour. At this time, the coverslips used to weight the valves and pelt down can be removed. No damage results if the structures are left for two days in the oil of cloves, but the stain is gradually leached out. Next, the genitalia and pelt are placed in xylene. An hour in the xylene may be sufficient for the valves, but it is desirable to leave the vesica, especially if large, and the bursa in the xylene for a day or two to harden. From xylene, the parts may go directly into Canada balsam.

If the bursa or the everted vesica looks flacid when it is first put into xylene, it can be re-inflated with a hypodermic syringe filled with xylene. A large, thin-walled bursa may collapse when transferred directly from xylene to balsam. By first transferring it into a mixture of 50% balsam, 50% xylene (for 1–2 hours), it can be moved into pure balsam without collapse. I tried three stages of various dilutions of balsam, but have found one intermediate stage works as well as any. This technique helps the vesica remain fully inflated, and I now treat all vesicae in this manner, though most of those in the figures were transferred directly into balsam. A three-dimensional, fully inflated bursa has proved to be important in constructing workable and reliable female genitalia keys. Flattened or improperly prepared female genitalia will be difficult, if not impossible, to key.

When mounting in balsam, a coverslip is held to the correct height, to prevent pressure on the bursa or vesica, by small rectangles of clear plastic tubing (calgol) cut to the depth of the structure. Three of these rectangles are placed on edge to support the coverslip. I have seen slides supported by a cross section of tubing in the form of a ring. This builds it up as well as containing the balsam. Unfortunately, this does not allow for the approximate 30% contraction of balsam upon drying and when these slides age, a bubble may form and distort the placement of the parts.

If a structure shifts in the balsam, it can be manipulated with a pin dipped in xylene and moved under the coverslip. This can usually be done easily even if the slide is prepared a year before if it is warmed. It is important to store thick slides in a flat, upright position even when they are several years old. The pelt is mounted under another coverslip to the left of the centrally placed genitalia. The slide number, species name, and label data are placed on a label to the right. This information is also recorded in a notebook and the slide number is put on the pinned adult. A species index on notecards is extremely useful for slide retrieval.

A dissection of the genitalia of each sex was freshly prepared, where material was available, as the best photographs could be had from new slides; older slides have darker balsam that tends to be darkest around the edges. When there was no reason to question the identity and extent of variation of a species, only two or three slides were prepared for each sex. Many genitalia slides were available from the Canadian National Collection, the United States National Museum, and the personal collection of J. G. Franclemont. Almost 1,000 genitalia preparations have been examined. Often the diagnostic characters of the genitalia could be examined merely by brushing the scales off the tip of the abdomen. In genera with very similar appearing species, such as those in *Papestra*, the genitalia of many specimens were examined by brushing off the scales.

MATERIAL EXAMINED

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KEY TO THE GENERA OF THE *POLIA* COMPLEX BASED UPON THE ADULT MACULATION

1. Basal dash prominent 2
— Basal dash absent (a thin hairline at most) 4
2. Media dash complete, extending from antemedial to postmedial line, or represented only by the distal half, near the postmedial line; abdominal tufting present on 3 or more segments 3
— Median dash represented proximally only, not extending to postmedial line, or entirely absent; abdominal tufts, if present, only on first segment . . . . *Lacanobia* (in part)
3. Forewing with broad, violet-gray postmedial band . . . . *Spiramater* (in part)
— Forewing with postmedial band barely distinguishable from ground . . . . *Lacanobia* (in part)
4. ♂ antennae serrate or filiform; if filiform, forewing with black wedges on innerside of subterminal line most prominent at anal angle, middle, and apex; subterminal line fading out at W-mark of subterminal line; usually 45 mm or more in wing expanse, except *richardsoni* which has an expanse of 25–38 mm, and eyes reduced and the hindwings black and white resembling an *Anarta*; median dash absent . . . . *Polia*
— ♂ antennae filiform; subterminal line if edged inwardly with black, the wedges not conspicuous between Cu2 and anal vein; subterminal line remaining strong at W-mark; usually less than 45 mm (average 35 mm) in wing expanse; median dash present or absent 5
5. Forewing entirely black and white; claviform indiscernible; hindwing grayish white; reniform pure white except in melanic forms . . . . *Melanchra* (in part)
— Forewing color variable, but if black and white then hindwing brownish (smokey) or the subterminal line only white, reniform dark 6
6. Forewing of one species (*picta*) completely deep red-brown, the others are very dark with a white patch in anal angle between Cu2 and the anal vein . . . . *Melanchra* (in part)
— Forewing never red-brown; if subterminal line conspicuously marked with white then the orbicular and other regions also marked with white or mottled with browns 7
7. Abdominal tufting absent; claviform a black wedge, usually filled with black; reniform filled with dark on the lower half . . . . *Trichordestra*
— Abdominal tufting present; claviform usually not a filled in black wedge; reniform light or dark, but never darker in lower half only 8
8. Reniform conspicuous, whitish; orbicular filled with same color as postmedial band; postmedial band violet, dark and tinged with rust color; annulus of reniform and subterminal line flesh colored . . *Spiramater* (in part)
— Reniform approximately same color and intensity as orbicular; postmedial band inconspicuous or light, never dark . . . . *Papestra*

KEY TO THE GENERA OF THE *POLIA* COMPLEX BASED UPON THE MALE GENITALIA

1. Ampulla (am, fig. 13) present; cucullus with anal spine (asp, fig. 14) (may have 2 anal spines); either basal tuft (bt, fig. 14) or apical tuft (at, fig. 22) well developed on left valve, weakly so on right; fixed penicular hairs (ph, fig. 10) lacking or weakly developed (except *imbrifera*); basal coremata (cti, fig. 196) well developed (*discalis*) to absent (*rogenhoferi*); vesica with a strengthening arch (sa, fig. 15) and distal cornuti (consisting of a cluster of spines) . . . . *Polia*
— Ampulla absent; cucullus without anal spine (cucullus may be very much reduced); valves frequently with asymmetrical clavi; penicular hairs and coremata variable; vesica without strengthening arch 2

2. Fixed penicular hairs absent .... *Melanchra*
— Fixed penicular hairs present (ph, fig. 10) 3
3. Coremata absent; cornuti of vesica short, less than or equal to width of aedeagus (this can be seen even if vesica is not everted 4
— Coremata (cti, fig. 196) present or absent, if absent then the cornuti long, 2 to 5x width of aedeagus 5
4. Valve with a centrally located basal process; free clavus (fc, fig. 53) present though weakly developed in some species; cornuti of vesica on a raised node .... *Lacanobia*
— Valve without a centrally located basal process; free clavus absent; cornuti not on a raised node; vesica a long spiral tube .... *Spiramater*
5. Vesica twice the length of aedeagus; process of costa (pc, fig. 72) obliquely crossing entire cucullus' neck; cucullus small, short and stout, flat-topped .... *Papestra*
— Vesica subequal in length to aedeagus; process of costa, if present, very short; cucullus well developed and rounded .... *Trichordestra*

KEY TO THE GENERA OF *POLIA* COMPLEX BASED UPON THE FEMALE GENITALIA

1. Bursa (b, fig. 88) with a simple, posteriorly directed appendix (apx, fig. 89) (bearing ductus seminalis) off of posterior, left portion of bursa .... *Polia*
— Bursa, when present, with appendix directed laterally or anteriorly; it may be absent or arising from the right portion of the bursa 2
2. Bursa rudimentary; appendix well developed, elongate, cylindrical and bears the ductus seminalis at its apex (figs. 115–118) .... *Papestra*
— Bursa present and well developed; appendix usually short, but if long then spiralling 3
3. Bursa with 4 bands 4
— Bursa with 3 bands .... *Trichordestra*
4. Appendix present or absent, when present it consists of a short stub off to the right .... *Melanchra*
— Appendix present, projecting to the left, may be long and spiralling or form a tight coil 5
5. Appendix long (nearly or as long as bursa) and spiralling; ductus bursa usually heavily chitinized; digitus present or absent .... *Spiramater*
— Appendix compact, one loop coil; ductus bursa weakly chitinized; digitus present .... *Lacanobia*

Polia Ochsenheimer

(Figs. 1, 4, 10, 90, 126)

Polia Ochsenheimer, 1816. Schmett. Eur., 4:73.
Type-species: *Phalaena nebulosa* Hufnagel, 1766. By subsequent designation by Curtis, 1829, Brit. Ent., 6:248.
Pseudotype: *Noctua compta* [Denis & Schiffermüller], 1775. By subsequent designation by Duponchel, 1829, *in* Godart & Duponchel, Hist. Nat. Lepid. Papillons Fr., 7(2):71.
Aplecta Guenée, 1838. Annals Soc. Ent. Fr., 7:217.
Type-species: *Phalaena nebulosa* Hufnagel, 1766. By subsequent designation by Guenée, 1852, *in* Boisduval & Guenée, Hist. Nat. Insectes (Lépid.) 6:77.

Head clothed with simple and bidentate scales; tongue well developed; labial palpi upcurved to lower one-third of front, segments 1 and 2 loosely sealed below, 3 closely scaled, segments 1 and 2 subequal, 3 about one-third length of 2 and bluntly rounded at apex; antennae variable (simple to narrowly bipectinate) with a pair of lateral setae (one on each side) per segment, scape wider than long, bulbous; epiphysis nearly half the length of fore tibia; tarsal segments with three rows of spines beneath; abdominal tufting and coremata variable.

Forewing length to width ratio variable (from 2.6:1 to 2.1:1); 12 veins reaching margin; margin crenulate; 3rd anal present at base; accessory cell present; $R_3\&_4$ stalked for one-fourth distance to apex, rarely with R_2 also stalked with $R_3\&_4$; M_3 midway between M_2 and Cu_1, or closest to M_2; M_1 from middle of accessory cell.

Average hindwing length to width ratio 1.5:1; margin crenulate; nine veins present, M_2 development variable, occasionally weak, located one-third distance from M_3 to M_1; R & M_1 and M_3 & Cu_1 not stalked; Cu_2 arises from three-fourths the length of cell.

Male genitalia: valves asymmetrical; apical or basal tufts of lower margin of valve strongly developed on left valve, weakly on right; fixed penicular hairs present or absent; valve with free lower arm; costa not strengthened; ampulla present; vesica with strengthening arch and distal cornuti forming a cluster of spines.

Female genitalia: signa variable, absent to one, two, three, or four complete bands; appendix a lobe protruding from the upper left portion of bursa in Nearctic species, occasionally arising from ductus bursa in some Palearctic species. Base of bursa more heavily chitinized than apex.

Of *Polia sensu stricto*, McDunnough listed nine species and six subspecies. Among these, *P. languida* is treated as a race of *P. purpurissata*, and *P. piniae* Buckett & Bauer has been described since McDunnough's list. *P. leomegra* is treated as a synonym and *P. carbonifera* is treated as a form of *P. rogenhoferi* Möschler. *P. richardsoni* is transferred from *Anarta* following Heydemann (1944) and Kozhanchikov (1947); its relationship with *Polia* was suggested by McDunnough in 1937, but he still treated it as an *Anarta* in his 1938 list. *Anarta magna* Barnes & Benjamin is treated as a race of *P. richardsoni*. One species previously misidentified is described as new. Heydemann listed 21 species for the Palearctic (including one Holarctic species); this brings the world total to 29.

KEY TO THE SPECIES OF *POLIA* BASED UPON THE ADULT MACULATION

1. Eyes reduced; a small species (wing expanse 25–38 mm, average 30 mm); hindwing white with broad black submarginal band (resembling an *Anarta*); mountain peaks and arctic regions . . . . *richardsoni*

— Eyes normal; large species (wing expanse usually 40 mm or more); hindwing white or fuscous, but with a diffuse submarginal band at most; generally and widely distributed 2

2. Subterminal wedge in fold prominent, broad, and not appearing split into two points by a "V" of subterminal line; wedge in fold (between Cu_2 and 2nd anal) at least as wide as distance of subterminal line to wing margin; abdominal tufts usually present on four of five segments, those on segments 3 and 4 being the largest; ♂ antennae serrate . . . . *imbrifera*

— Subterminal wedge in fold usually appears divided when prominent and/or narrower than the distance of subterminal line to margin; abdominal tufts usually lacking; ♂ antennae short bipectinate or simple 3

3. W-mark pronounced, extending to terminal line; reniform with lower corner angled toward orbicular; forewing with light patches beyond reniform and in fold, giving wing streaked appearance; hindwing nearly white . . . . *nugatis*

— W-mark rarely extending to terminal line, usually weakly developed or subterminal line may even fade out at this point; reniform rarely angled toward orbicular; forewing never with light areas beyond reniform *and* in fold; hindwing fuscous, at least at the margin 4

4. Subterminal wedge in fold rarely split, usually forming a tapering, diffuse black line to base of W-mark; forewing usually with rusty tinge through or beyond reniform; ♂ antennae short bipectinate . . . . *purpurissata*

— Subterminal wedge in fold often obscured, but usually appearing as two points split by a "V" of subterminal line, the upper wedge larger; wedge in fold never forming a tapering line to W-mark; forewing never with rusty tinge through or beyond reniform; ♂ antennae simple 5

5. Forewing gray to brown with postmedial line and ordinary spots conspicuous, or if obscured, then forewing dark brown 6

— Forewing blue-gray to ash-gray with postmedial line obscured, especially toward inner margin; pattern washed out 9

6. Forewing dark brown, pattern may be indistinct . . . . *rogenhoferi* form *carbonifera*

— Forewing light gray or brownish gray with complete pattern 7

7. Postmedial line consisting of a series of white crescents edged with dark; forewing darkest before orbicular and between orbicular and reniform and occasionally along costa in submarginal area . . . . *nimbosa*

— Postmedial line dark, bordered with light distally; forewing uniformly colored throughout; white scaling, when present, confined to edge of reniform 8

8. Tegula with 3- and 4-toothed scales; pattern always contrasty; all ordinary lines complete . . . . *propodea*

— Tegula with bidentate scales; pattern may or may not be contrasty . . . . *rogenhoferi*

9. Hindwing dusky, discal mark usually appearing broader than nearby veins; forewing with area between orbicular and reniform contrasty; the larger terminal tibial spur of metathoracic leg 5x to 8x longer than width at base (with scale covering intact); west coast . . . . *piniae*

— Hindwings usually white in areas bordering range of *piniae*, discal mark same width as nearby veins; area between reniform and orbicular contrasty or not; generally distributed in the Rocky Mountains and eastward; the large terminal tibial spur of metathoracic leg 3x to 4x longer than width at base (in portion of range bordering *piniae*) . . . . *discalis*

KEY TO THE SPECIES OF *POLIA* BASED UPON THE MALE GENITALIA

1. Basal tuft (bt, fig. 14) well developed; apical tuft (at, fig. 22) reduced in comparison 6

— Apical tuft well developed, at least as prominent as basal tuft 2

2. Anal spines of cucullus (asp, fig. 14) two per valve 3

— Anal spines one per valve 4

3. Clavus (cl, fig. 14) quadrate . . . . *rogenhoferi*

— Clavus rounded . . . . *propodea*

4. Lower margin of valve with apex broadly bilobate . . . . *richardsoni*

— Lower margin of valve with apex a single blunt point 5

5. Apex of lower margin of valve protruding into area of anal loop (excavation below cucullus) . . . . *purpurissata*

— Apex of lower margin of valve not protruding into area of anal loop . . . . *nugatis*

6. Penicular hairs (ph, fig. 10) present and well developed (more prominent than the weakly developed basal tuft of valve); lower arm of valve long, narrow, and pointed . . . . *imbrifera*

— Penicular hairs absent or very weak; basal tuft prominent 7

7. Coremata (eta, fig. 196) absent; clavus a flat, square-topped ridge . . . . *nimbosa*

— Coremata present; clavus a long, blunt, rounded lobe 8

8. Width of base of left basal tuft only 1/3 to 3/8 the length of the remainder of valve; ampulla clublike (am, fig. 13) extending beyond costal margin of valve; cornuti (cor, fig. 11) on vesica usually present . . . . *piniae*

— Width of left basal tuft subequal in length to remainder of lower arm of valve; ampulla parallel sided and seldom broadened into a club, rarely reaching beyond costal margin of valve; cornuti absent . . . . *discalis*

KEY TO THE SPECIES OF *POLIA* BASED UPON THE FEMALE GENITALIA

1. Bursa without signa or bands 2

— Bursa with at least one signum 4

2. Appendix with a wide gap between it and the ductus bursa (appendix appearing as a lobe off the posterior or basal left region of the bursa . . . . *propodea*

— Appendix approximate to (may even touch) ductus bursa 3

3. Entire length of genitalia 7 mm or less; 7th sternite only 1/3 or less the area of 7th tergite . . . . *richardsoni*

— Entire length of genitalia 10 mm or more; 7th sternite nearly the same area as 7th tergite . . . . *rogenhoferi*

4. Bursa with 1, 2, or 3 short signa, if more than 1 then the signa at 160° from midline of venter of bursa (dorsal, right side) is distinctly the largest 5

— Bursa with 2 or more signa or bandlike signa, the one at 160° subequal in size to the one opposite 6

5. Bursa much greater in diameter at widest point than girth at origin of appendix . . . . *purpurissata*

— Bursa almost the same diameter throughout . . . . *nugatis*

6. Four signa or bandlike signa present (usually 2 weak and 2 strong) 7

— Only 2 signa present . . . . *discalis*

7. Four bandlike signa running nearly ½ to ¾ the length of bursa . . . . *piniae*

— Bandlike signa very short, less than ¼ length of bursa or frequently broken into small segments 8

8. Appendix walls folded together appearing as if collapsed; dorsal and ventral signa oval, almost round ....*imbrifera*
— Appendix walls not folded, but well developed and protruding; dorsal and ventral signa elongate, forming short bands ....*nimbosa*

Polia discalis Grote

(Figs. 1, 18, 19, 90, 131, 132 and Map 1)

Mamestra discalis Grote, 1877. *In* Uhler, Bull. U.S. Geological & Geographical Survey Territories, 3:797. Smith, 1893. Bull. U.S. Natl. Mus., 44:114. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:82.

Type locality: Clear Creek Canyon [Colorado] [BM(NH)].

Polia discalis, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:67, pl. 80, fig. 7. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Ground light ash gray; front with brown and white bidentate scales; brown transverse band on middle of front (broken in middle); palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with weak, spreading tufts; tegula with 2- and 3-dentate scales and considerable hairlike scales; abdomen without tufts; coremata present; wings with ordinary lines and spots; W-mark present although subterminal line vague at this point; orbicular and reniform frequently fade into ground on lower margins.

Male genitalia: (Figs. 18, 19) T.L.M. slide no. 29.

Female genitalia: (Fig. 90) T.L.M. slide no. 86.

Alar expanse: 42–56 mm.

Food plant: Willow (Forbes, 1954).

Polia discalis is closely related to *P. nebulosa*. This species, *P. piniae*, and the Holarctic *P. richardsoni* are the only North American *Polia* with well-developed coremata. By comparison, 20 of the 21 Palearctic species of *Polia* possess coremata (Heydemann, 1944). Some of the remaining Nearctic *Polia* show evidence of reduced or lost coremata (e.g., *P. nimbosa*), possessing only the pocket or the "lever."

P. discalis is dark gray in the Black Hills of South Dakota, north to North Dakota, and west into Wyoming. More northern specimens and specimens from Utah, Nevada, Colorado, and Montana are very light gray. The two color forms blend into each other and the genitalia show no differences. This may be another example of a relict fauna associated with earlier vegetative events (Johnson, 1975).

Specimens examined were taken from June 8 to August 15.

Specimens examined: 95. ALBERTA: Calgary, July 8–15 [USNM]; 2 mi. NE. Seebe, July 12, 1966 J. Scott & C. Curtis [USNM]; Crowsnest Pass 4,500′, July 16, 1966 D. C. Ferguson [USNM]; ARIZONA: Walnut Canyon 6,500′, 6.3 mi. EESE. Flagstaff, Coconino Co., July 24, 30 and August 6, 1965 J. G. Franclemont [JGF]; West Fork 6,500′, 16 mi. SW. Flagstaff, July 11, 1961 J. G. Franclemont [JGF]; Fort Valley 7,350′, 7.5 mi. NW. Flagstaff, July 11, 1961 J. G. Franclemont [JGF]; Greer, White Mts., 8,300′, June 26, 1968 R. H. Leuschner [RHL]. COLORADO: Lump Gulch, Gilpin Co., August 1, 1962 T. W. Davies [LACM]; Estes Park, Larimer Co., 7,800′, July 21, 1967 A. & M. E. Blanchard [LACM]; Estes Park, Larimer Co., 7,800′, July 21, 29, 1967 D. C. Ferguson [USNM]; Big Thompson Canyon, Larimer Co., 6,500′, July 9, 1955 R. H. Leuschner [RHL]; 10 mi. SE. Steamboat Springs, Routt Co., 8,200′, July 28, 1962 Buckett & Trenam [DAVIS]; Florissant, Teller Co., 8,640′, July 19, 21, 1965, July 25, 27, 1962 T. C. Emmel [LACM]; Glenwood Springs, July 10 [DAVIS]; Glenwood Springs, July 1895 [USNM]; Rocky Mt. Nat. Pk., July 24, 1936 R. H. Andrews [LACM]; Redstone Camp, 5 mi. N. Redstone, June 8, 1976 C. P. Bagdonas [CPB]; Lower Rist Canyon, 18 mi. W. Ft. Collins, June 29, 1975, June 26 and July 13, 1976 C. P. Bagdonas [CPB]. MONTANA: Little Timber Park, 5,743′, Crazy Mts., Sweet Grass Co., July 8, 1969 J. G. Franclemont [JGF]; Big Timber Canyon, Crazy Mts., July 25, 1966 D. C. Ferguson [USNM]; Half Moon Park, 6,500′, Crazy Mts., Sweet Grass Co., July 22, 1969 J. G. Franclemont [JGF]; 7.75 mi. N. Big Timber, Sweet Grass Co., July 9 through 30, 1969 J. G. Franclemont [JGF]; 5 mi. N. Lake Theboe, Teton Co., July 23, 1976 T. L. McCabe [TLM]. NEVADA: Angel Creek, 7,000′, E. Humboldt Mts., SSW. Wells, Elko Co., July 18, 1971 D. C. Ferguson [USNM]; Angel Lake Rd. above Wells, Elko Co., 7,000′, July 20, 1971 D. C. Ferguson [USNM]; 2 mi. S. Jarbridge, Elko Co., August 9, 1967 J. Emmel & O. Shields [LACM]. NEW MEXICO: Sangre de Cristo Mts., Colfax Co., 7,900′, July 7, 1962 E. Munroe [CNC]; Jemez Springs, August 8–15 [USNM].

NORTH DAKOTA: 2 mi. S. Keene, McKenzie Co., July 18, 1973 P. K. Lago [TLM]. SOUTH DAKOTA: Deadwood, Black Hills, 4,000′, July 20, 1958 R. H. Leuschner [RHL]; Joe Dollar Gulch, Hill City, Black Hills, July 10 through 22, 1964 D. C. Ferguson [USNM]. UTAH: 11 mi. NW. Helper, Carbon Co., August 5, 1964 [DAVIS]; Bryce Canyon Park, Garfield Co., 8,200′, July 15, 1957 R. H. Leuschner [RHL]; Strawberry Mts., Wasatch Co., July 17, 1960 W. A. Hammer [LACM]; Snake Creek, 3 mi. NW. of Midway, Wasatch Co., August 1, 1971 D. C. Ferguson [USNM]; Eureka, July 10 T. Spalding [LACM]. WYOMING: 5 mi. N. Sundance, Crook Co., 5,900′, July 9 through July 11, 1963 F. Rindge [AMNH].

Polia piniae Buckett & Bauer

(Figs. 16, 17, 89, 130 and Map 1)

Polia piniae Buckett & Bauer, 1967. Journ. Res. Lep., 5:221.

Type locality: Johnsville, Plumas Co., California [DAVIS].

Front with brown and white bidentate scales, a partial (broken in middle), transverse band on middle of front; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with very weak spreading crests; tegula clothed with 2- and 3-dentate scales and considerable hair; abdomen often with weak tufts on first three or four segments; coremata present; forewing blue-gray; W-mark present, although subterminal line often vague at this point; orbicular and reniform frequently fading into ground on lower margins; postmedian line vague, often absent toward inner margin.

Male genitalia: (Figs. 16, 17) T.L.M. slide no. 112.

Female genitalia: (Fig. 89) T.L.M. slide no. 113.

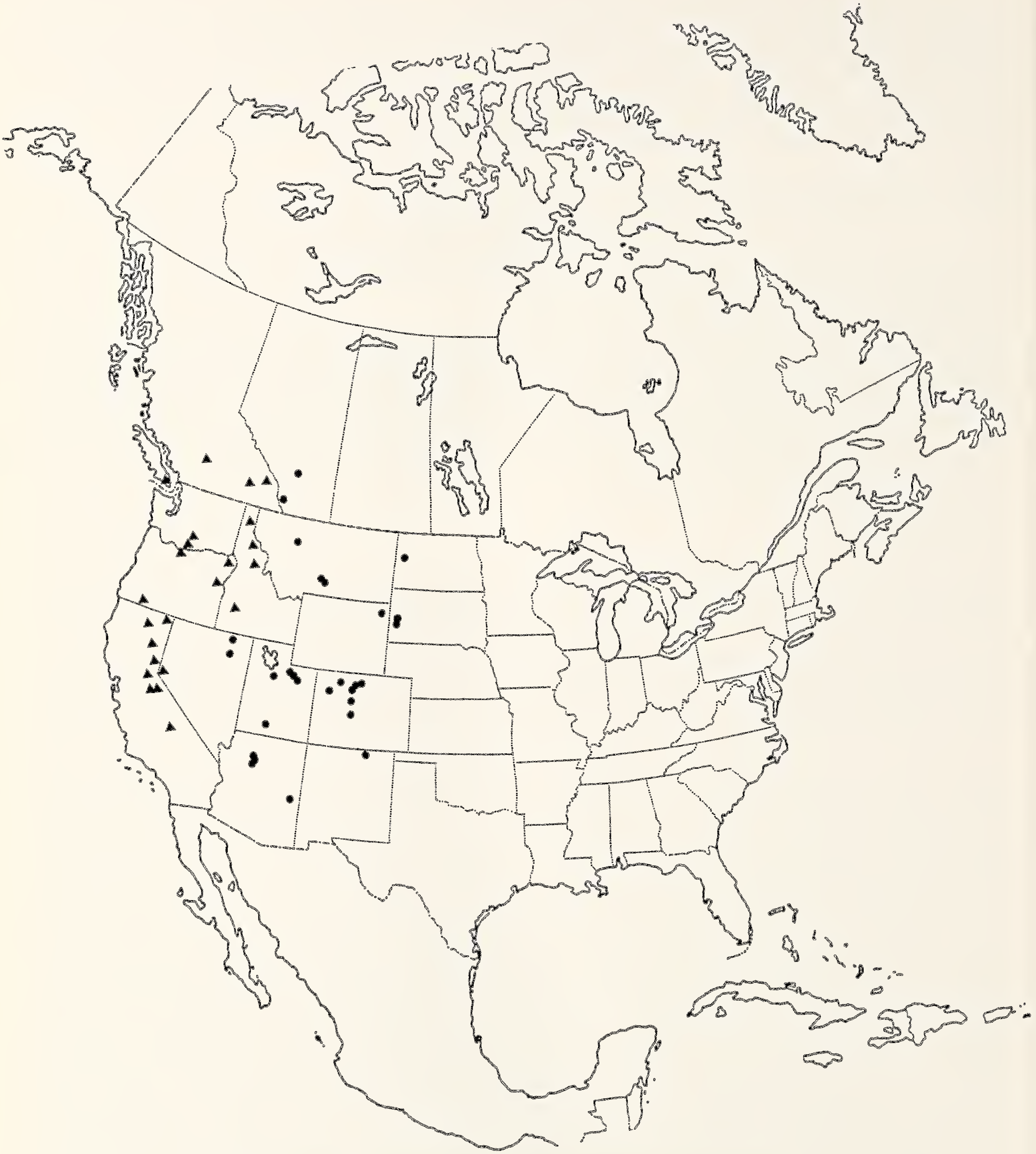
Alar expanse: 45–56 mm.

Food plant: unknown.

This species and *P. discalis* are extremely close in adult habitus and male genitalia. *P. piniae* is a recently described species, and it had masqueraded in collections as *P. discalis* until the female genitalia were examined. The female bursa has four, long bandlike signa whereas *P. discalis* has only two, short signa.

The ranges of these two species approach one another in Idaho and British Columbia, but I have never seen both species from the same locality. Where the ranges of the two species are approximate, the adults can be distinguished by slight color differences as well as the characters mentioned in the keys. *P. piniae* is consistent in adult habitus throughout its range, though in the North it resembles *P. discalis* closely except that the hindwings are a little more dusky. Specimens examined were taken July 3 to August 27.

Specimens examined: 156. BRITISH COLUMBIA: Shaw Springs, August 26, 1963, L. V. Bower; Arrowhead Lake, July 24-31 [USNM]; Duncan, Vancouver Island, July 27, 1912 [USNM]; Kaslo, August 6, 1909 [LACM]; Kaslo [USNM]; Kaslo, H. G. Dyar coll. [AMNH]; Robson, July 17, 1936, August 1, 1936 H. R. Foxlee [JGF]; 28 mi. S. Radium Hot Springs, 2,600′, July 23, 1960 D. F. Hardwick [CNC]. CALIFORNIA: Localities cited by Buckett & Bauer (1966): Johnsville, Plumas Co., July 6 to August 11, 1962–65 H. J. Pini; Mohawk, Plumas Co., July 4 to 12, 1946 W. R. Bauer; Mt. Ingallis, Plumas Co., July 11, 1964 W. R. Bauer, J. S. Buckett & M. R. Gardner; Pinecrest, Tuolumne Co., July 2 to 25, 1965 R. Mason; 2 mi. W. Sonora Pass, Tuolumne Co., July 1, 1966 G. M. Buxton; Wentworth Springs, El Dorado Co., July 8, 1961 W. E. Simonds; Donner Lake, Nevada Co., July 20, 1962 G. M. Buxton; Carnelian Bay, Placer Co., July 12, 1965 F. D. Parker; Manzanita Lake, Shasta Co., August 13, 1963 G. M. Buxton; Hat Creek, Shasta Co., July 26, 1964 R. R. Pinger; Cedar Pass, 6 mi. NW. Cedarville, Modoc Co., July 4, 1962 W. R. Bauer, J. S. Buckett & G. M. Trenam; Lasser Creek, north of Davis Creek, Modoc Co., July 28, 1957 W. R. Bauer and J. S. Buckett; Mineral King, Tulare Co., July 19, 1963 W. E. Simonds. IDAHO: 13 mi. NE. Garden Vly., Boise Co., August 1, 19, 1971 and July 4 to 24, 1972 O. B. Howell [LACM]; Badger Creek, 3,500′, Idaho Co., July 4, 1976 T. L. McCabe [TLM]; 2 mi. SE. Osburn, Shoshone Co., July 22, 1976 T. L. McCabe [TLM]; Wallace, July 1–27 O. Buchholz [AMNH]. OREGON: Spring Creek, Blue Mts., 4,000′, Baker Co., July 5, 1972 D. C. Ferguson [USNM]; Spring Creek, Baker, July 3, 1968 J. H. Baker [RHL]; Baker, July 10, 1968 J. Baker [AMNH]; 3 mi. S. Ashland, Jackson Co., 3,500′, July 22, 1966 J. Powell [UCB]; nr. Joseph, Wallowa Co., July 11, 13, 1949 and July 13, 1954 J. L. Sperry [LACM & AMNH]; Mayer St. Pk., Wasco Co., 550′, July 21, 1976 T. L. McCabe [TLM]. WASHINGTON: Satus Pass (Goldendale), Kickitat Co., August 16, 1953 E. Henriksen [RHL]; 4.5 mi. W. Railroad Sta. 1,300′, Yakima Co., August 8, 1967 E. J. Newcomer [LACM]; Hot Springs, Green River, July 18–23 [USNM].



Map 1.—Geographical distribution of members of *Polia*.

● *Polia discalis* Grote ▲ *Polia piniae* Buckett & Bauer

Polia nimbosa Guenée

(Figs. 12, 13, 88, 127–129)

Aplecta nimbosa Guenée, 1852. Hist. Nat. Ins. (Lépid.) 6:77.
Type locality: "Amerique Septentrionale" [BM(NH)].
Mamestra nimbosa, Smith, 1893. Bull. U.S. Natl. Mus., 44:114. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:83.
Mamestra mystica Smith, 1898. Ent. News, 9:242. Dyar, 1902. A list of North American Lepidoptera, U.S. Natl. Mus. Bull., 52:156.
Type locality: Winnipeg, Manitoba [USNM].
Polia nimbosa, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:115, pl. 81, fig. 14. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.
Polia mystica, Hampson, 1905, Cat. Lep. Phal. Brit. Mus., 5:115, pl. 81, fig. 15.
Polia nimbosa ssp. *mysticoides* Barnes & Benjamin, 1924. Ent. News, 35:7. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.
Type locality: Duncans, Vancouver Island, British Columbia [USNM].

Front with complete or partially complete transverse band of bidentate brown scales at middle; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with prominent, divided anterior crest, posterior crest weak, divided; tegula with 3-, 4-, 5-, and 6-dentate scales; abdomen without tufts or only a weak basal one; coremata absent, but the pocket present; forewing with ground light to dark gray; W-mark present, but not well set off.

Male genitalia: (Figs. 12, 13) T.L.M. slide no. 218.

Female genitalia: (Fig. 88) T.L.M. slide no. 55.

Alar expanse: 44–65 mm.

Food plants: red alder, huckleberry, and vine apple, *Ribes*, and *Alnus* (Godfrey, 1972).

P. nimbosa is closely related to *P. nebulosa* and was considered a subspecies of it by Heydemann (1944): "Eine sbsp. *nimbosa* Gn. kommt in Nordamerika vor." Pierce's illustration of *P. nebulosa* shows the male genitalia as symmetrical, but examination of dissections shows them to be asymmetrical. There was a tendency for drawings made during this period to be "balanced" unless the asymmetry was pronounced. *P. nebulosa* has a long basal tuft (bt, fig. 14) on the left valve and just a trace of one on the right valve. The clavus is flat in *P. nebulosa*, but very protuberant in *P. nimbosa*. In *P. nimbosa*, the bursa has the bandlike signa showing more fusion of the expanded areas than in *P. nebulosa* and points toward the type of signa found in *P. piniae*.

Polia nimbosa has two described subspecies: *P. n. mystica* Smith and *P. n. mysticoides* Barnes & Benjamin. *P. n. mystica* is a northern subspecies (described from Winnipeg, Manitoba) and is comparable to the northern population of *P. imbrifera* in Newfoundland (see discussion of *P. imbrifera*). Except for size, I could find no genitalic differences in any of the subspecies of *P. nimbosa*. As with many described subspecies, *P. n. mystica* is found at the edge of the species range and represents the end of a cline.

The width of the basal tuft compared to the remainder of the arm of the valve (a useful character for distinguishing the *P. discalis* male from its sibling, *P. piniae*) is subject to variations in *P. nimbosa* and not reliable for distinguishing *P. n. mystica*.

P. n. mysticoides is the Vancouver Island population of *P. nimbosa*. It also occurs on mainland British Columbia and eastward nearly to Alberta where it blends into typical *P. nimbosa*. In the southern Appalachians, *P. nimbosa* averages larger and lighter, reminiscent of the Vancouver Island specimens, but with the ordinary lines and spots more distinct.

Specimens examined were taken June 19 to July 27. The species is distributed from southern Canada south to Washington in the West and south to North Carolina in the East. It is very common in collections.

Specimens were examined from the following states and provinces: Alberta, British Columbia, Manitoba, Nova Scotia, Quebec, Saskatchewan, Idaho, Maine, Minnesota, Montana, New York, North Carolina, North Dakota, Pennsylvania, Vermont, Washington, and Wisconsin.

Polia imbrifera Guenée
(Figs. 4, 10, 11, 87, 126)

Aplecta imbrifera Guenée, 1852. Hist. Natl. Ins. (Lépid.) 6:76.

Type locality: New York [BM(NH)].

Mamestra imbrifera, Smith, 1893. Bull. U.S. Natl. Mus., 44:114. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:82.

Polia imbrifera, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:68, pl. 80, fig. 8. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front with weak transverse band of bidentate scales at middle; palpi upcurved to lower fourth of front; male antennae subserrate, segments unifasciculate on each side; female antennae simple; thorax with strong, divided, anterior crest and a weak, divided, posterior crest; tegula clothed with broad (10 scales to width of tegula) 3-, 4-, and 5-dentate scales; abdomen with tufts on the first five segments, tufts on segments 3 and 4 largest and subequal; coremata absent; forewing with ground gray-brown; wings with normal lines and spots; W-mark absent.

Male genitalia: (Figs. 10, 11) T.L.M. slide no. 194.

Female genitalia: (Fig. 87) T.L.M. slide no. 122.

Alar expanse: 40–53 mm.

Food plants: chokecherry, *Salix* spp., *Betula lenta* L., *B. populifolia* Marsh., and *Alnus rugosa* (Du Roi) (Godfrey, 1972).

The adult of *P. imbrifera* resembles the Eurasian *Pachetra sagittigera* Hufnagel. However, *P. sagittigera* has a number of peculiarities that indicate an isolated form that warrants placement in a genus of its own. *P. sagittigera* has the juxta with a unique series of spines, unusually long cornuti on the vesica which lacks the strengthening arch so characteristic of the species of *Polia*. The Palearctic species of *Polia* often have longer cornuti than the Nearctic species (e.g., *P. hepatica* Clerck). *Pachetra sagittigera* has an anal spine and an ampulla on each valve. On this basis, Heydemann considered it a *Polia*, but Fletcher (1972) resurrected the genus *Pachetra* for it. Significant differences from *Polia* include the aforementioned peculiar cornuti, absence of the strengthening arch, and presence of a very large, well-developed appendix. The Palearctic species of *Polia* show a tendency toward larger appendices as well as a posterior shift of the appendix toward the ductus bursae (e.g., *P. bombycina* Hufnagel).

P. imbrifera is superficially very close to *nimbosa* and the genotype, *P. nebulosa*. Of all the *Polia*, *P. imbrifera* has the most nearly symmetrical valves. The similarity to *P. nimbosa* extends to the larval stages (Godfrey, 1972). The female of *P. nebulosa* and this species both have four, broken, bandlike signa. The habitus is similar to that of *P. nimbosa*, and they are occasionally mixed in collections. However, only *P. imbrifera* has prominent abdominal tufts.

P. imbrifera genitalia show a mixture of ancestral and derived states. It has well-developed penicular hairs (the only Nearctic *Polia* with such hairs), four bandlike signa; the coremata are absent, and the valves are nearly symmetrical (all other Nearctic species of *Polia* show marked asymmetry).

The antennae of *P. imbrifera* are subserrate, *P. nimbosa* has weakly subserrate antennae, and the related *P. discalis* has simple antennae. The three species are closely related in genitalic structure. This demonstrates how unreliable the antennae, used in the past, are for defining groups in *Polia*.

P. imbrifera is consistent in adult habitus as evidenced by the lack of synonyms and race names. Specimens collected by D. C. Ferguson in Newfoundland are smaller and have a more brownish appearance, but this is not an unexpected variation when one considers the northern latitude. Canadian specimens from north of the Great Lakes are darker and bear some superficial resemblance to *P. rogenhoferi*.

Specimens examined were taken from June 14 to August 7. This species is distributed across Canada and south to Utah and North Carolina.

Specimens were examined from the following states and provinces: British Columbia, Manitoba, Newfoundland, Nova Scotia, Ontario, Quebec, Colorado, Maine, Michigan, Minnesota, Montana, New Mexico, New York, North Carolina, North Dakota, Pennsylvania, Utah, Vermont, and Virginia.

Polia propodea sp. nov.
(Figs. 20, 21, 91, 135 and Map 2)

Mamestra rogenhoferi, Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:82. Misdetermination.

Polia rogenhoferi, McDunnough, 1938. Mem. S. California Acad. Sci., 1:69. Misdetermination.

Front covered with brown and white, weakly bidentate scales; palpi upcurved to lower fourth of front; male antennae weakly serrate, segments bifasciculate on each side; female antennae simple; thorax with weak divided anterior and posterior crests; tegula clothed with bluntly 3- and 4-dentate scales and some hair; abdomen with tufts on the first four segments, those of segments 1 and 3 being the largest; coremata absent; forewing with ground ashy gray-brown; pattern contrasty, lines conspicuously scalloped; reniform occasionally extending toward orbicular.

Male genitalia: (Figs. 20, 21) T.L.M. slide no. 260.

Female genitalia: (Fig. 91) T.L.M. slide no. 134.

Alar expanse: 37–45 mm.

Food plant: unknown.

HOLOTYPE: ♂. Echo Lake, Mt. Evans, 10,600′, Colorado, July 29, 1961 E. W. Rockburne [CNC].

PARATYPES: same data as type, 6 ♂, 1 ♀, July 13–28, 1961 E. W. Rockburne [CNC]; 3 ♂, Sci. Lodge, Ward, Boulder Co., 9,500′, Mt. Evans, Colorado, July 25, 31, and August 1, 1961 E. W. Rockburne [CNC]; 1 ♂, Lake Louise, 5,000′, Alberta, July 20, 1960 D. F. Hardwick [CNC]; 1 ♂, Manning Park, 5,500′, British Columbia, August 10, 1953 J. E. H. Martin [CNC]; 1 ♂, Nain (Barnes Coll.), Labrador [USNM]; 1 ♂, Gander, Newfoundland, July 29, 1949 R. A. Henninger [CNC]; 3 ♂, 1 ♀, Doyles, Codroy Vly., Newfoundland, July 28, 30, and August 4, 1962 D. C. Ferguson [USNM]; 1 ♂, Cascapedia, Quebec, August 2, 1932 M. L. Prebble [CNC].

I assumed this species was the true *rogenhoferi* and it was determined by McDunnough in the Canadian National Collection as this species; Ferguson also thought it to be the true *rogenhoferi*. The confusion apparently came about because Möschler's type of *rogenhoferi* is lost. I tried to locate the type in the Bereich Zoologisches Museum, the Naturhistorisches Museum at Vienna, the Paris Museum, the United States National Museum, the American Museum of Natural History, and the British Museum. Smith, apparently the last person to see the type, had borrowed it from Möschler; he illustrated part of the male valve (Proc. U.S. Natl. Mus., Vol. 14, pl. 8, fig. 2) which he "snapped off" the type. Möschler died in 1888, about the time when Smith would have been returning the specimen. I believe Smith returned the moth unaware of Möschler's death, and the specimen was lost. Smith's illustration of the right valve, coupled with the type description, represents the species I identify with the name.

In the type description of *P. rogenhoferi*, the wing expanse is given as 47–48 mm. The male type, examined by Smith, was 47 mm. *Polia propodea* is a smaller species, the largest specimen examined had an expanse of only 45 mm. The right valve of *P. rogenhoferi*, depicted by Smith, has the outer angle ("heel") of the cucullus smoothly rounded; that of *P. propodea* is crenulate. So far, *P. propodea* has not been recorded from southern Labrador, the type locality for *P. rogenhoferi*. However, it is likely both species occur there, though the northern limits of *P. propodea* in the East may be in Newfoundland.

The most distinct differences between *P. propodea* and typical *P. rogenhoferi* (form *carbonifera* is much darker) are genitalic. The male valve of *P. propodea* has a rounded clavus; that of *P. rogenhoferi* has a rather flat-topped clavus. The females of *P. propodea* have the appendix well separated from the ductus bursae; that of *P. rogenhoferi* has the appendix approximate to or contiguous with the ductus bursae. They are difficult to distinguish on adult habitus, especially eastern, contrasty specimens of *P. rogenhoferi*. *P. propodea* has the tegula clothed with 3- and 4-dentate scales; that of *P. rogenhoferi* is clothed with bidentate scales. *P. propodea* is apparently rare, but the records indicate a wide distribution in the northern latitudes and at high altitudes.

Polia rogenhoferi Möschler

(Figs. 22, 23, 92, 133, 134 and Map 2)

Mamestra rogenhoferi Möschler, 1870. Entomologische Zeitung, Stettin, 31:269. Smith, 1893. Bull. U.S. Natl. Mus., 44:114.

Type locality: "Sudliches Labrador" [type lost, represented by original description and illustration of male valve in Smith, 1891, Proc. U.S. Natl. Mus., Vol. 14, pl. 8, fig. 2].

Mamestra leomegra Smith, 1908. Ann. New York Acad. Sci., 18:100. NEW SYNONYMY. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:82.

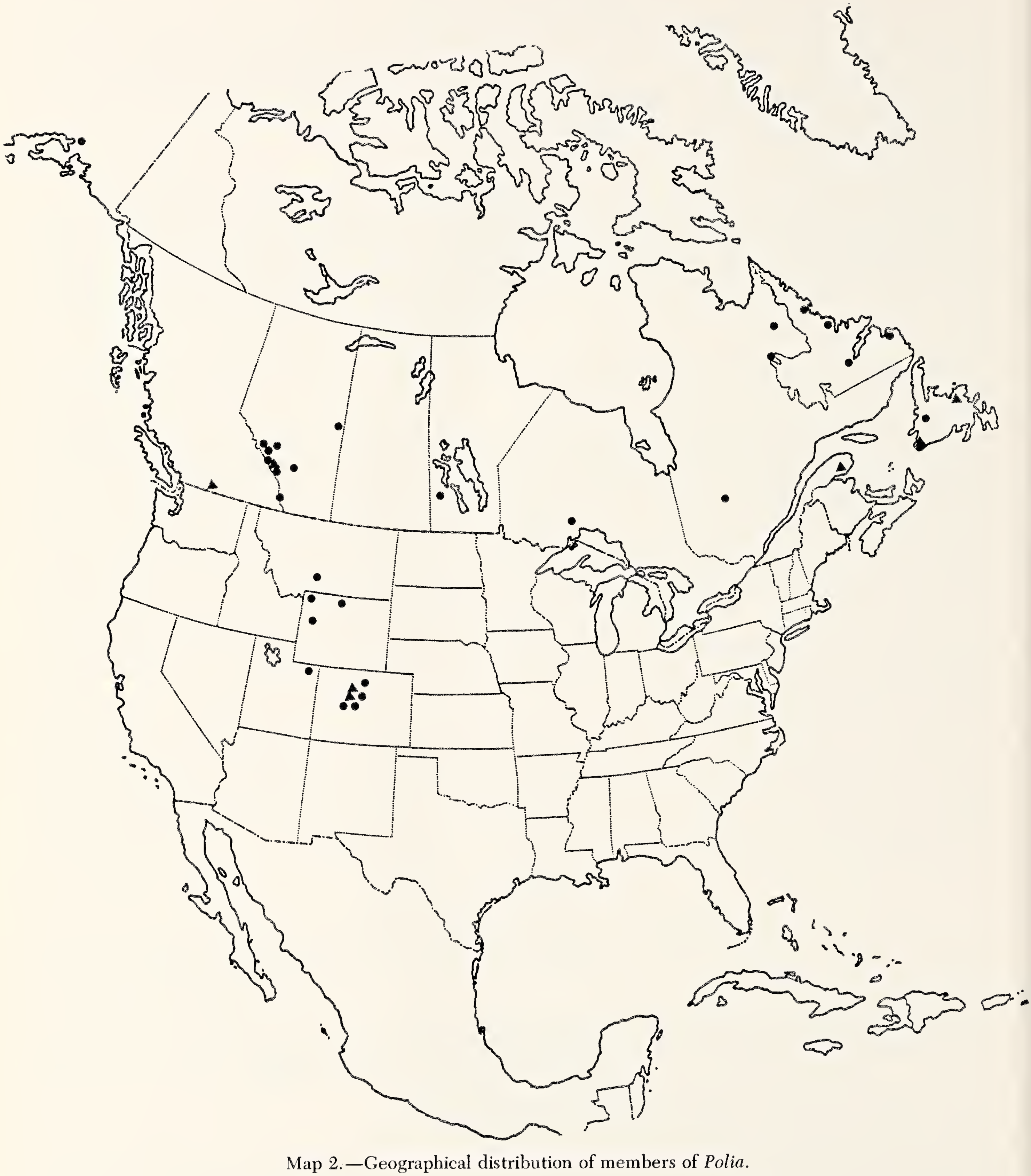
Type locality: Grand Lake, Newfoundland [AMNH].

Miselia carbonifera Hampson, 1908. Can. Ent., 40:104. NEW SYNONYMY.

Type locality: Wilcox Pass, Alberta.

Polia rogenhoferi, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:113, pl. 81, fig. 12.

Polia leomegra, McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.



Map 2.—Geographical distribution of members of *Polia.*

● *Polia rogenhoferi* Möschler ▲ *Polia propodea* McCabe

Front covered with brown and white bidentate scales; palpi upcurved to lower fourth of front; male antennae weakly serrate, segments bifasciculate on each side; female antennae simple; thorax with weak, divided anterior and posterior crests; tegula clothed with mostly bidentate and some 3- and 4-dentate scales and hair; abdomen with basal tuft most prominent, the remaining tufts very weak or absent; coremata absent; forewing with ground ashy gray-brown to sooty black; wings with ordinary lines and spots present or obscured (form *carbonifera*).

Male genitalia: (Figs. 22, 23) T.L.M. slide no. 237.

Female genitalia: (Fig. 92) T.L.M. slide no. 144.

Alar expanse: 43–55 mm.

Food plant: unknown.

Polia rogenhoferi ranges across Canada and southward in the Rocky Mountains to Utah. The darker, less contrasty form, *carbonifera* Hampson, occurs in the West to the exclusion of typical *P. rogenhoferi*. The form *carbonifera* is uncommon in the East and intermediate specimens exist which are probably heterozygotes for the apparent melanism.

This species and *P. propodea* belong to the same group as the Palearctic *P. bombycina* Hufnagel, which represents an older element because it has a more elaborate appendix and four bandlike signa. According to Berge (1899), *P. bombycina* feeds on: "Heidelbeeren, esenpfrieme, Hauhechel (*Ononis spinosa*), auch im Herbst an Birken." *Polia rogenhoferi* will probably feed on blueberry and/or birch.

Specimens examined were taken June 2 to August 16.

Specimens examined: 94. ALBERTA: Lake Louis, 5,000′, July 20, 1960 D. F. Hardwick [CNC]; 45 mi. NW. L. Louise, 4,800′, July 22, 1961 D. F. Hardwick [CNC]; Bow Pass, 6,700′, 25 mi. NW. L. Louise, July 21, 1961 D. F. Hardwick [CNC]; Crowsnest Pass, 4,500′, July 16, 17, 1966 D. C. Ferguson [USNM]; Storm Mt. Lodge, 5,400′, 4 mi. E. Vermilion Pass, July 15, 1966 D. C. Ferguson [USNM]; Nigel Creek, Banff Nat. Pk., August 2, 1966 J. Scott & C. Curtis [USNM]; Nordegg, June 2 to July 6, 1921 J. McDunnough [CNC]; Nordegg, June 23 to July 7, 1921 J. McDunnough [USNM]; Nordegg, July 17, 1918 [USNM]; Banff [USNM]; ; Eisenhower Jct., Banff Nat. Park, 5,000′, July 29, 1966 J. Scott & C. Curtis [USNM]; Calgary, July 4, 1904 F. H. Wolley Dod [CNC]; Wilcox Pass, 1907 [AMNH]. BRITISH COLUMBIA: Manning Park, 4,000′, August 6, 1960 D. F. Hardwick [CNC]. LABRADOR: Cartwright, July 26, 1955 E. E. Sterns [CNC]; Goose Bay, July 29, 1948 W. E. Beckel [CNC]; Hopedale, July 24–31 [USNM]; Nain [USNM]. MANITOBA: Riding Mts., June 29, 1936 May [JGF]. NEW BRUNSWICK: Ashton Hill, Tower, July 14, 1962 [USNM]. NEWFOUNDLAND: Grand Lake, August 28 O. Bryant [AMNH]; Doyles, Codroy Vly., July 25 to August 10, 1962 D. C. Ferguson [USNM]. ONTARIO: Black Sturgeon L., July 11, 1963 [USNM] and July 12, 1961 [CNC]. QUEBEC: Indian House Lake, July 18, 1954 W. R. Richards [CNC]; Knob Lake, July 19 and August 16, 1948 E. G. Munroe [CNC]; Mistassini, August 4, 8, 1956 J. R. McGillis [CNC]. ALASKA: Palmer, July 24 [USNM]. COLORADO: Weston Pass, 10,000′, Lake Co., July 18, 1975 C. P. Bagdonas [CPB & TLM]; Aspen, Maroon Bells, Pitkin Co., July 8, 1976 C. P. Bagdonas [CPB & TLM]; 12 mi. WNW. Estes Park, 11,600′, July 28, 1967 D. F. Hardwick [CNC]; Doolittle Ranch, 9,800′, Mt. Evans, July 30, and August 5, 1961 E. W. Rockburne [CNC]. MONTANA: Half Moon Park, 6,500′, Crazy Mts., Sweet Grass Co., July 20, 1969 J. G. Franclemont [JGF]. UTAH: Iron Springs Campground, 25 mi. N. Vernal, Uintah Co., 8,700′, July 19, 1963 F. Rindge [AMNH]. WYOMING: 34 mi. E. Lovell, Big Horn Co., 8,900′, July 22, 1959 F. Rindge [AMNH]; Yellowstone Nat. Pk., 7,800′, July 17, 1955 F. Hartig [AMNH]; Green River Lake, Wind River Range, July 24 and August 7, 1935 A. B. Klots [MINN].

Polia richardsoni Curtis

(Figs. 24, 25, 93, 136, 137)

Hadena richardsoni Curtis, 1835. App. to Ross, Narr. Second Voy., 72, pl. A. fig. 11.

Type locality: [lat. 69°48′10″; long. 92°23′09″; 15 miles from River Tatchick (Eskimo name), 200 miles south of Port Bowen, very near Comptroller's Islands] [USNM].

Anarta algida Lefebvre, 1836. Ann. Soc. Ent. Fr., 5:395, pl. 10, fig. 5. Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:40.

Type locality: Europe [not determined].

Anarta septentrionis Walker, 1857. List Spec. Lep. Insects Coll. Brit. Mus., (11):700. Smith, 1893. Bull. U.S. Natl.

Mus., 44:293. McDunnough, 1938. Mem. S. California Acad. Sci., 1:72.

Type locality: Repulse Bay, Melville Peninsula, Northwest Territories [BM(NH)].

Mamestra feildeni M'Lachlan, 1878. Jour. Linn. Soc., 14:112. McDunnough, 1938. Mem. S. California Acad. Sci., 1:72.

Type locality: Dobbin Bay, Grinnel Land, Northwest Territories [not determined].

Anarta richardsoni, Smith, 1893. Bull. U.S. Natl. Mus., 44:293. Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:39, pl. 39, fig. 12. McDunnough, 1938. Mem. S. California Acad. Sci., 1:72. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:94.

Anarta lanuginosa Smith, 1900. Proc. Wash. Acad. Sci., 2:492. McDunnough, 1938. Mem. S. California Acad. Sci., 1:72.

Type locality: Alaska [USNM].

Anarta asiatica Staudinger, 1901, Cat. Lep. Pal., 218.

Type locality: East Siberia [not determined].

Anarta dovrensis Staudinger, 1901. Cat. Lep. Pal., 218. Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:40. Heydemann, 1944. Stettiner Ent. Zeitung, 105:21.

Type locality: Norway [not determined].

Anarta richardsoni squara Smith, 1908. Ann. New York Acad. Sci., 18(2):112. McDunnough, 1938. Mem. S. California Acad. Sci., 1:72. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:95.

Type locality: Greenland [AMNH].

Anarta magna Barnes & Benjamin, 1924. Contri. Nat. Hist. Lep. N. A., 5(3):117-118. NEW SYNONYMY. McDunnough, 1938. Mem. S. California Acad. Sci., 1:72.

Type locality: Bullion Peak, Park Co., Colorado [USNM].

Anarta richardsoni tamsi Benjamin, 1933. Pan-Pacific Ent., 11(2):58. McDunnough, 1938. Mem. S. California Acad. Sci., 1:72. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:95.

Type locality: Hopedale, Labrador [USNM].

Anarta richardsoni groenlandica Heydemann, 1944. Stettiner Ent. Zeitung, 105:22-23, pl. 2, fig. 315b; pl. 5, figs. 337, 315a; pl. 7, figs. 5, 6, 6a.

Type locality: East Greenland [not determined].

Aplecta richardsoni, Heydemann, 1944. Stettiner Ent. Zeitung, 105:21.

Polia richardsoni, Kozhanchikov, 1947. Ent. Obozrenie 29:12-35.

Front with a broad, black transverse band composed of hairlike scales; palpi upcurved nearly to middle of front; male antennae serrate, unifasciculate on each side; female antennae simple; thorax without crests; tegula clothed with mostly hairlike scales and some bidentate scales; abdomen with basal tuft, weak tufts on segments 2 and 3 may be present; coremata present; forewing with ground dark brown; W-mark absent; claviform a black wedge.

Male genitalia: (Figs. 24, 25) T.L.M. slide no. 207.

Female genitalia: (Fig. 93) T.L.M. slide no. 248.

Alar expanse: 25–38 mm.

Food plant: *Oxyria*, *Saxifraga oppositifolia*, *&* *Salix artica* (Mackay, 1972).

LECTOTYPE: present designation: A ♂ specimen, having descended through the collections of Doubleday, Guenée, Oberthür, and Barnes, is in the United States National Museum, bearing the following labels: 1) Ex Musaeo Ach. Guenée, 2) *Hadena* 18 *richardsoni* Curt., 3) [label illegibly handwritten in French], 4) Oberthür collection, 5) ♂ gen. 247, 29 Mar 32 FHB, 6) Barnes Coll., 7) *Anarta richardsoni* Curt. Type No. ____ USNM, 8) Genitalia slide by ____ USNM 37141. [USNM].

Heydemann (1944, p. 25) considered *P. richardsoni* to be the most primitive member in the genus on the basis of its genitalia, distribution, and developmental history: "M. E. die primitivst gebaut und wohl auch entwicklungsgeschichtlich älteste Art des Gattung *Aplectá* [=*Polia*] was ebenfalls dureh die zirkumpolar Verbreitung unterstichen wird." He also considered it and *P. lamuta* Hertz to be unique: "Von ihr dürfte sich die nur nordeurasische *lamuta* als nächste Verwandte ableiten." Actually, *P. richardsoni* is related to the Nearctic *P. purpurissata* and to the Palearctic *P. hepatica* Clerck. Heydemann conceded that his "Polare Nord-Gruppe" (which contained *P. richardsoni*) served as a connecting link to "*Aplecta tincta* Brahm" = *Polia hepatica*). Heydemann must have attached considerable importance to the Holarctic distribution when he stated it was the oldest species in the genus. Genitalic characters indicate a derived condition (e.g., signa and penicular hairs are absent). The small eyes and conspicuous markings are no doubt adaptive for diurnal activity as is the case in many arctic species. *Polia richardsoni* appears to be the oldest element in the "*purpurissata* group" of the genus on the basis of distribution, size (Cope's Rule) and presence of coremata.

The subspecies of *P. richardsoni* will not be treated in detail here, as Heydemann (1944) and Benjamin (1933) have already done so. However, *Anarta magna*, standing in our lists as a valid species, represents a relict population of *P. richardsoni* and is treated as a subspecies of it. *Polia r. magna* is known from the type locality, Bullion Peak (13,000′), Park Co., Colorado (represented by two females in the United States National Museum) and from one male from the Bear Tooth Plateau, 10,000′, Park Co., Wyoming (in the Franclemont collection). The fact that relict populations of *P. richardsoni* exist on mountain peaks in the Nearctic, but are apparently absent from the mountains of the Palearctic, indicates an invasion (or re-invasion) into Eurasia by this species since the last glaciation.

The female type of *magna* has genitalia identical to nominate *P. richardsoni*. The differences between *P. r. magna* and *P. richardsoni* eited in the original deseription includes: ". . . is larger, lacks all trace of orange and ochreous scaling, while the whole appearance of the primaries is more suffused and less contrasty . . . ." Heydemann (1944, p. 22) wrote about the females of a race of *P. richardsoni*: ". . . die ♀ ♀ besonders verwaschen und variebel." Heydemann discussed many color variants, many of which lack orange or ochreous scaling and several which are as large as *P. r. magna*.

Heydemann's subspecies "*groenlandica*" is likely to be equivalent to Smith's subspecies "*squara*." They both occur on Greenland though Heydemann's type locality was east Greenland. I have not seen "*groenlandica*" and treat it as a valid subspecies. Heydemann (1944) considered *P. lamuta* (Herz) to be a sibling species of *P. richardsoni*, but Kozhanchikov (1947) considered *P. lamuta* as well as *P. ragnowi* (Püngeler) to be synonyms of *P. asiatica* (Staudinger). The right valve of *P. asiatica* is figured by Kozhanchikov (1947) and is hardly distinct from nominate *P. richardsoni*. *P. ragnowi* has a female appendix much larger than that of *P. richardsoni*. I have followed Hampson (1905) in treating *algida*, *dovrensis*, and *asiatica* as synonyms, but the Palearctic forms, *Anarta? fumida* Graeser, *Polia tunkinski* O.B.-H., *P. ragnowi* Püngeler, and *P. lamuta* Herz have not been considered in the present work on Nearctic species and will have to wait for a detailed study on a world basis of the polytypic *P. richardsoni*.

The larva of *P. richardsoni* (figured by MacKay, 1972) lack inner mandibular teeth, unlike all other *Polia* larvae examined.

Specimens examined were taken June 24 to August 22. The latest date for northern Canadian material was July 31. The species is Holarctic and is usually found above 55° latitude in North America. Specimens were examined from Alaska, Colorado, Wyoming, Quebec, the Northwest Territories, and Greenland.

Polia purpurissata Grote

(Figs. 28–33, 95, 96, 139–142)

Eurois purpurissata Grote, 1864. Proc. Ent. Soc. Philadelphia, 3:82, pl. 1.
Type locality: Pennsylvania [not determined].

Hadena juncimacula Smith, 1882. Bull. Brooklyn Ent. Soc., 5:67. NEW STATUS. Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:69, pl. 80, fig. 10.
Type locality: "Utah?" [USNM].

Mamestra purpurissata var. *crydina* Dyar, 1904. Can. Ent., 36:32. NEW STATUS.
Type locality: Kaslo, British Columbia [USNM].

Mamestra purpurissata, Smith, 1893. Bull. U.S. Natl. Mus., 44:114. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:83.

Mamestra languida Smith, 1893. Ent. News, 4:100, pl. 6, fig. 6. NEW SYNONYMY. Dyar, 1902. A list of North American Lepidoptera, Bull. U.S. Natl. Mus., 52:155. Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:69, pl. 86, fig. 6. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.
Type locality: Colorado [USNM].

Polia (Mamestra) apurpura Barnes & McDunnough, 1913. Contri. Nat. Hist. Lep. N. A., 2(3):106, pl. 7, fig. 2.
Type locality: White Mountains, Arizona [USNM].

Polia purpurissata, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:70, pl. 70, fig. 20. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front with weak (may be broken in middle) transverse band of bidentate scales at middle; palpi upcurved to lower fourth of front; male antennae serrate and unifasciculate on each side; female antennae simple; thorax with divided anterior crest and weak divided posterior crest; tegula clothed with mostly bidentate scales and hair; abdomen without tufts or only a weak basal tuft; coremata absent; forewing with ground blue-gray, frequently with a rusty or pinkish cast; W-mark present though subterminal line frequently fading out at this point.

Male genitalia: (Figs. 28-33) T.L.M. slide no. 262. U.S.N.M. slide no. 1949.

Female genitalia: (Fig. 95) T.L.M. slide no. 264.

Alar expanse: 38-54 mm.

Food plant: *Vaccinium canadense*, *V. pennsylvanicum*, *Myrica splenifolia*, *Alnus*, *Betula populifolia*, *Nepeta hederacea*, *Acer*, *Spiraea latifolia*, *Symphoricarpos albus*, *Lonicera tatarica* (Godfrey, 1972). *Prunus virginiana* L. (feeding on leaves at night) [JGF & TLM]. *Vaccinium myrtilloides* Michx., and *V. stamineum* L. [TLM].

Polia purpurissata ranges across much of North America and is subject to considerable variation. These populations have frequently been described as species or subspecies (*P. p. crydina* Dyar, *P. juncimacula* Smith, *P. apurpura* Barnes & Benjamin, and *P. languida* Smith). The overall tendency is for darker forewings in the far Northwest and Northeast and with the forewings becoming less contrasty in the East and the hindwings becoming lighter in the West and Southwest. I have treated the subspecific names as synonyms where they represent the end of a cline (see classification section).

The subspecies names used in *P. purpurissata* are for populations which are often sympatric with other subspecies over much of their range (except *P. p. apurpura*). The subspecies "*crydina*" could be considered an end of a cline (a northwest population), but in reality it is only an extreme morph of a population which has forms like "*juncimacula*" and even typical northeastern *P. purpurissata*. The type series of "*crydina*" (21 specimens) contains nearly the whole gamut of variations of *P. purpurissata* phenotypes. Overall, western specimens show more variability than eastern ones, but even in the West the typical eastern form occurs. I have treated *P. languida* as a subspecies of *P. purpurissata* because the genitalia fall well within the variation observed in *P. purpurissata*. *P. p. languida* was described from one specimen and may have been reared or it may represent a hybrid between *P. purpurissata* and *P. nugatis*.

I have examined the genitalia of specimens of all the subspecies and have found variability in all, but no consistent pattern was evident. The bursa may have one, two, or three signa. The male valves vary in width and the ampulla varies in length, width, and curvature. Reared series from females were not available because of the difficulty in rearing. The larvae overwinter and apparently change hosts (Godfrey, 1972).

Specimens were examined from the following provinces and states; Alberta, Manitoba, Nova Scotia, Ontario, Quebec, Arizona, California, Colorado, Idaho, Maine, Michigan, Minnesota, New Mexico, New York, North Dakota, Oregon, South Dakota, and Utah. It is very common in collections.

Polia nugatis Smith

(Figs. 26, 27, 94, 138 and Map 3)

Mamestra nugatis Smith, 1898. Ent. News, 9:240. Dyar, 1902 [1903]. A list of North American Lepidoptera, Bull. U.S. Natl. Mus., 52:156.

Type locality: Montana, Nevada [USNM].

Mamestra tufa Smith, 1905. Jour. New York Ent. Soc., 13:199. NEW STATUS.

Type locality: Stockton, Utah [AMNH].

Polia nugatis, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:68, pl. 80, fig. 9. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front with transverse brown band composed of bidentate scales at middle; palpi upcurved to middle of front; male antennae serrate and unifasciculate on each side; female antennae simple; thorax with divided anterior and posterior crests; tegula clothed with 2-, 3-, and 4-dentate scales; abdomen without tufts or with only a weak basal one; coremata absent; forewing with ground silver-gray with a slight tan cast; general appearance streaked; ordinary lines frequently obscure; reniform extending to or nearly to orbicular; W-mark present.

Male genitalia: (Figs. 26, 27) T.L.M. slide no. 13.

Female genitalia: (Fig. 94) T.L.M. slide no. 238.

Alar expanse: 42–52 mm.

Food plant: *Artemesia*, *Salix* accepted initially (Godfrey, 1972).

Polia nugatis is closely related to *P. purpurissata*. In *P. nugatis* the reniform is angled inward to the orbicular and can be used to separate the two species in most cases. However, the angled reniform occasionally occurs in some populations of *P. purpurissata*. This angled condition is uncommonly seen in other *Polia* (e.g., *P. propodea*) as well as *Papestra quadrata* and *Melanchra picta*. The angled reniform gives the wing a somewhat streaky appearance and may be cryptic. *P. nugatis* is sympatric with *P. purpurissata*, though *P. purpurissata* has a much broader distribution. Franclemont (pers. comm.) found that *P. nugatis* was commonly encountered in sage habitats whereas *P. purpurissata* was more general, but uncommon in sage. Crumb (1956) reported the larvae of *P. nugatis* on sage, but Godfrey (1972) could not get the first instars to accept sage and had limited success with willow (*Salix* sp.).

Smith's subspecies "*tufa*" cannot be sorted from typical *P. nugatis* without the locality and it is treated as a straight synonym of *P. nugatis*. Specimens examined were collected July 11 to September 17.

Specimens examined: 118. CALIFORNIA: Warner Mts., Lassen Co., August 15–19, 1962 W. Rees & R. Reid [LACM], August 5–10 L. M. Martin [LACM]; Monachee Meadows, 8,000′, Tulare Co., July 27, 1928 J. S. Garth [USNM]; Truckee, August 1–7 [USNM]; Mamouth, 8,500′, Inyo Co., July 18, 1972 [LACM]. COLORADO: Glenwood Springs, August 8–15 [USNM]; Green River, August 14, 1976 C. P. Bagdonas [CPB & TLM]. MONTANA: 7.75 mi. N. Big Timber, Sweet Grass Co., August 5–22, 1969 J. G. Franclemont [JGF]; NE. side Howie Rd., ¼ mi. from Gibson Rd., 4,500′, Sweet Grass Co., August 21, 1969 J. G Franclemont [JGF]; Richel Lodge, August 8–30 J. Sperry [AMNH]; Joliet, 4,100′, September 3, 1964 D. F. Hardwick [CNC]. NEVADA: Kingston Canyon, Toiyabe Range, 5,600′, August 5, 1967 J. Emmel & O. Shields [LACM]; Reno, September 16–23 [USNM]; Ruby Mts., August 7, 1967 J. Emmel & O. Shields [LACM]. OREGON: Chief Joseph Mt., Wallowa Co., July 11, 1949 J. Sperry [LACM]. UTAH: Eureka, August 15–30, 1911 T. Spalding [USNM, LACM, JGF]; Beaver, 6,300′, August 28, 1965 D. F. Hardwick [CNC]; Stockton, September 1, 1904 T. Spalding [LACM]. WYOMING: 11 mi. S. Arvada, 3,600′, September 14, 1964 D. F. Hardwick [CNC]; Riverton, 5,700′, (28 mi. NW.) September 17, 1964 D. F. Hardwick [CNC]; Yellowstone Nat. Pk., August [USNM].

Melanchra Hübner

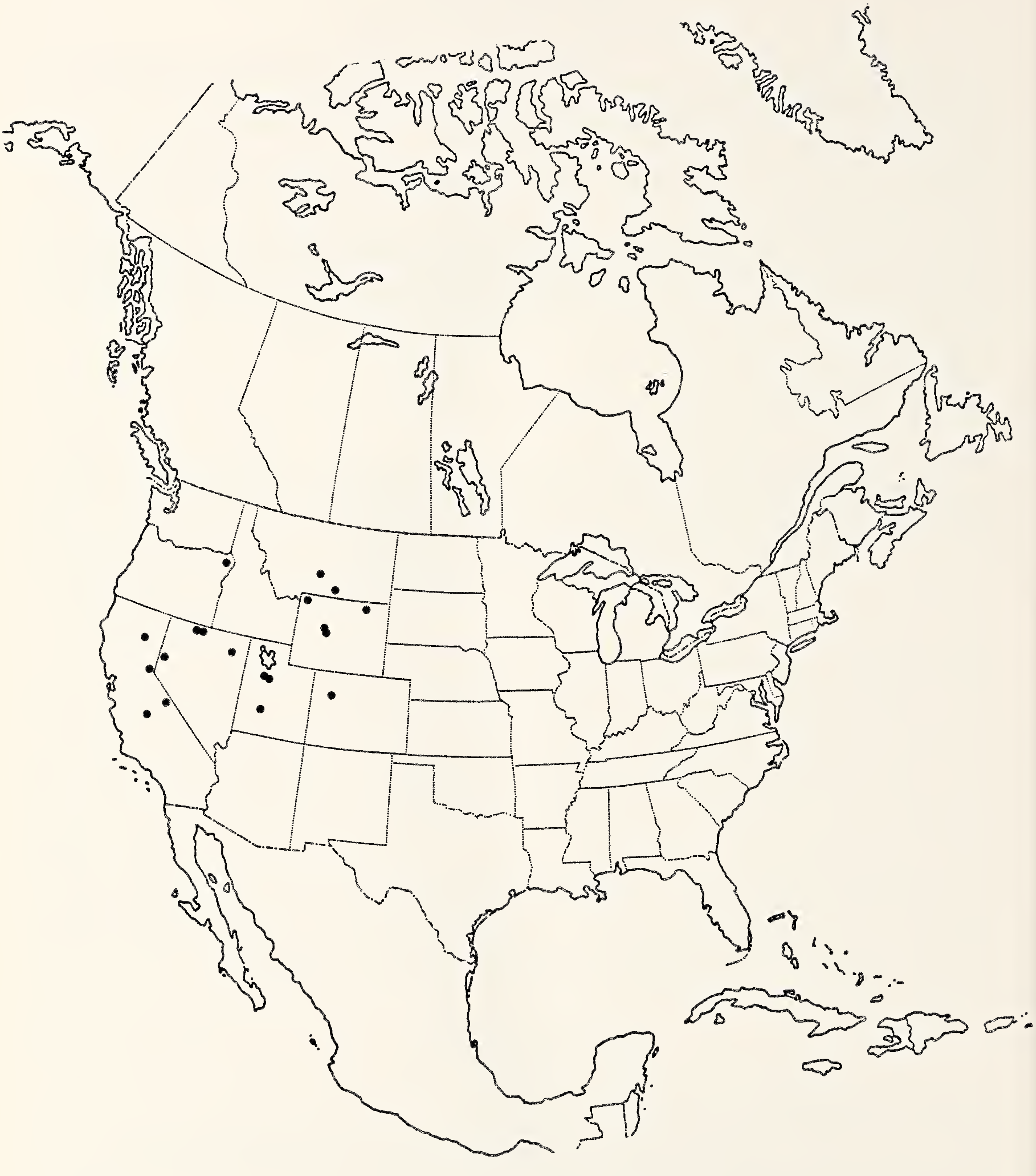
(Figs. 7, 8, 34, 97, 143)

Melanchra Hübner, [1820] 1816. Verz. bekannter Schmett. :207.

Type-species: *Phalaena Noctua persicariae* Linnaeus, 1761. Fauna Suecica (Edn. 2):319 by monotypy.

Ceramica Guenée, 1852. *In* Boisduval & Guenée, Hist. Nat. Insectes (Lépid.) 5:343 NEW SYNONYMY.

Type-species: *Ceramica exusta* Guenée, 1852. *In* Boisduval & Guenée, Hist. Nat. Insectes (Lépid.) 5:344, p. 5, fig. 9, by subsequent designation by Grote, 1874. Bull. Buffalo Soc. Nat. Sci., 2:22.



Map 3.—Geographical distribution of *Polia nugatis* Smith.

Head densely covered with upright simple and bidentate scales; tongue well developed; labial palpi upcurved to lower fourth of front, segments one and two loosely scaled, three closely scaled; second segment of palpi one and a half times the length of the first and four times the length of the third; third palpal segment acute at apex; antennae simple, ciliate, segments unisetose on each side; scape wider than long, bulbous; epiphysis half the length of fore tibia; tarsi with three rows of spinules; abdominal tufts and coremata variable.

Forewing average length to width ratio 2.2:1; margin weakly crenulate; 12 veins present; 3rd anal present only at base; accessory cell present; R_3&$_4$ stalked for one-third to one half the distance to apex; M_3 midway between M_2 & Cu_1; M_1 from middle of accessory cell. Hindwing average length to width ratio: 1.5:1; margin weakly crenulate; 9 veins present; M_2 weak and located one-third the distance from M_3 to M_1; R & M_1 stalked for a short distance; M_3 & Cu_1 not stalked; Cu_2 arises from three-fourths the length of cell.

Male genitalia: costa and cucullus together forming an inwardly directed lobe or projection; costa tubular, heavily sclerotized; clavus variable; fixed penicular hairs absent; subscaphium often developed; aedeagus terminating in one or two spines; vesicae with or without distal cornuti.

Female genitalia: four bandlike signa; ductus bursae very heavily sclerotized, frequently expanded; appendix, when apparent, projecting to the right; ductus seminalis originating from apex of appendix.

Melanchra adjuncta is closely related to the Palearctic *M. persicariae*, the genotype. The similarity extends to the larvae, both possessing chevronlike markings and have the eighth abdominal segment humped. The development of the subscaphium and the "spurred" aedeagus are characteristic of this genus. Fletcher (1972) placed the European *M. pisi* L. in *Ceramica*. The genotype of *Ceramica* is *C. picta* Harris (*C. exusta* Guenée is a synonym of *C. picta*). "*Ceramica*" *picta* and *Melanchra adjuncta* are very close in the male genitalia and I have synonymized *Ceramica*. Both show the same characteristic aedeagus mentioned above, and they have similar costal projections and cuculli of the valves. The larvae are dissimilar, probably an adaptive feature reflecting behavioral differences. *Melanchra adjuncta* larvae rest curled up amongst dense foliage or in flower clusters, whereas in *M. assimilis* and other species with striped larvae, the larvae rest parallel with the stem and frequently bury the head in a leaf axil to further disrupt the caterpillar outline. All *Melanchra* species studied are polyphagous.

The Palearctic *M. pisi*, and Nearctic *M. assimilis* and *M. pulverulenta* form a closely united species group more distant morphologically from *M. picta* and *M. adjuncta* than these two are from one another. In *M. assimilis*, the development of the subscaphium is similar to that of *M. adjuncta*; in *M. picta* it is very weak.

M. adjuncta and *M. persicariae* are the oldest elements in the genus, possessing abdominal tufts, male coremata, a well-developed subscaphium and clavi. The *M. persicariae* group and the *M. pisi* group have Palearctic and Nearctic species. *Melanchra* consists of four species in the Nearctic. They range across Canada and southward to Washington (*M. assimilis*) and California (*M. pulverulenta*) in the West and Virginia (*M. picta*) and North Carolina (*M. adjuncta*) in the East.

KEY TO THE SPECIES OF *MELANCHRA* BASED UPON THE ADULT MACULATION

1. Forewing red-brown . . . . *picta*
— Forewing gray or black 2
2. Abdomen with tufts beyond basal segment; reniform white (melanic form "*benjamini*" has a wholly dark forewing) . . . . *adjuncta*
— Abdomen without tufts; reniform dark; white patch along subterminal line in fold 3
3. Forewing smooth, inky black with weak, broken, white subterminal line often represented at anal angle only; reniform finely outlined by more intense black . . . . *assimilis*
— Forewing with some dark reddish-brown in area of reniform; subterminal line broken, but conspicuous the entire length . . . . *pulverulenta*

KEY TO THE SPECIES OF *MELANCHRA* BASED UPON THE MALE GENITALIA

1. Only two "upward projections" from valve, the cucullus and a projection of the costa; vesica short, bulbous .... *adjuncta*
— Valve with three "upward projections": the cucullus, the free costa, and a median lobe in between; vesica long and tapering 2
2. Uncus broadened at apex; lobes of valve short, center lobe barely projecting .... *picta*
— Uncus pointed; lobes all well developed 3
3. Middle lobe extending the farthest distally .... *pulverulenta*
— Middle lobe not extending beyond other lobes, apex in line with apices of other two lobes .... *assimilis*

KEY TO THE SPECIES OF *MELANCHRA* BASED UPON THE FEMALE GENITALIA

1. Appendix vestigial; bandlike signa broken .... *adjuncta*
— Appendix present; signa continuous 2
2. Appendix with origin on ductus bursae .... *picta*
— Appendix with origin from base of bursa 3
3. Ductus bursae expanded to the right and to the left .... *assimilis*
— Ductus bursae expanded to the right only .... *pulverulenta*

Melanchra adjuncta Boisduval, new combination

(Figs. 8, 34, 35, 97, 143, 144)

Miselia adjuncta Boisduval, 1841. *In* Guenée, Noct. Ind. Meth., 243.
Type locality: New York [BM(NH)].
Acronicta declarata Walker, 1856, Cat. Lep. Nat. Brit. Mus., 9:61.
Type locality: Canada [Hope Museum, Oxford (not verified)].
Mamestra adjuncta, Smith, 1893. Bull. U.S. Natl. Mus., 44:46. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:85.
Polia adjuncta, Hampson, 1905. Cat. Phal. Brit. Mus., 5:117, pl. 81, fig. 17. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.
Polia adjuncta form *benjamini* Lemmer, 1937. Bull. Brooklyn Ent. Soc., 32:22.
Type locality: Lakehurst, New Jersey [AMNH].

Front clothed with a mixture of light and dark bidentate scales, partial transverse band may be present on middle of front; palpi upcurved nearly to middle of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with divided anterior and posterior crests; tegula with very broad (6–7 scales to width of tegula), multidentate (6–10 shallow teeth) scales that are black or white in color; abdomen with tufts on first three or four segments, those on segments two and three largest and subequal; coremata present; forewing ground black, ordinary lines and spots present; W-mark present.

Male genitalia: (Figs. 34, 35) T.L.M. slide no. 219.

Female genitalia: (Fig. 97) T.L.M. slide no. 85.

Alar expanse: 29–38 mm.

Food plant: *Solidago canadensis* L., *Pteridium aquilinum* (L.) Kuhn, *Weigelia rosea*, *Ranunculus occidentalis*, *Ribes*, *Rubus spectabilis*, *Sambucus*, *Salix*, *Alnus*, *Ulmus*, *Lonicera tatarica* L., *Lotus corniculatus* L., *Taraxacum*, *Medicago sativa* L. (Godfrey, 1972). *Thalictrum polygamum* Muhl. [TLM].

M. adjuncta is similar to the Eurasian *M. persicariae*, the genotype, in male and female genitalia, adult habitus, and larval structure and pattern. The female of *M. persicariae*, as illustrated by Pierce (1909), has an elongate ductus bursae. The Nearctic *M. adjuncta* has the ductus bursae folded upon itself, giving it the appearance of having a much shorter ductus bursa than *M. persicariae*.

Pierce (1909, p. 33) discusses the female signa of *M. persicariae:* "Signa four, band-like, consisting of six irregular patches joined together." This is similar to the condition in *M. adjuncta*. It is interesting that primitive species in two genera, *Polia* and *Melanchra*, each have signa that are composed of interrupted or narrowly fused patches. Four continuous fused bands are considered to be the ancestral state, as evidenced by their occurrence in so many trifid noetuid genera and species (also Dollo's Law). Yet when bandlike signa tend toward reduction (*P. purpurissata*), the bands shorten until only a single, anterior, circular signum remains, and then they disappear altogether. One would expect the bands to break up into many patches to attain the *persicariae-adjuncta* condition. Perhaps this condition results from a cessation at some stage of development of the pupa, or secondary fusion of separate signa may have taken place in an early trifid noctuid ancestral type.

Specimens examined were taken in May, July, August, and September; the species has at least two broods. The species is distributed from Canada south to Utah and North Carolina.

Specimens examined: 500 from the following provinces and states: Alberta, Manitoba, Nova Scotia, Ontario, Quebec, Saskatchewan, Connecticut, Idaho, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New York, North Dakota, Ohio, Oregon, Pennsylvania, South Dakota, Utah, Virginia, Wisconsin, and Wyoming. The species if very common in Canadian, Transitional, and Upper Austral zones.

Melanchra picta Harris, new combination

(Figs. 7, 36, 37, 98, 145)

Mamestra picta Harris, 1841. Rept. Ins. Mass., 329. Smith, 1893. Bull. U.S. Natl. Mus., 44:120.
Type locality: Massachusetts [MCZ].
Ceramica exusta Guenée, 1852. Spec. Gen. Noct., 1:344.
Type locality: North America [MNHN, Paris].
Mythimna contraria Walker, 1856. Cat. Lep. Nat. Brit. Mus., 11:78.
Type locality: Cambridge, Massachusetts [BM(NH)].
Ceramica picta, Hampson, 1905. Cat. Phal. Brit. Mus., 5:446, fig. 124, p. 446. McDunnough, 1938. Mem. S. California Acad. Sci., 1:76. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:106.

Front clothed with a uniform mixture of reddish and light-tipped reddish, simple scales; palpi upcurved to lower front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with narrow 2- and 3-dentate scales and considerable hair; abdomen without tufts or only a weak basal tuft; coremata absent; forewing with ground reddish-brown; ordinary lines reduced or absent, only the subterminal frequently present; reniform usually present and occasionally extending to orbicular; orbicular conspicuous to absent; W-mark present.

Male genitalia: (Figs. 36, 37) T.L.M. slide no. 225.

Female genitalia: (Fig. 98) T.L.M. slide no. 224.

Alar expanse: 30–40 mm.

Food plant: Willow and cabbage most frequently listed (Godfrey, 1972). A general feeder.

LECTOTYPE: present designation. A ♂ in the Harris collection, bearing the following labels: 1) 112, 2) *Mamestra*? allied to it, 3) 330A. [MCZ].

The female bursa of *M. picta* has a long, elbowed appendix directed laterally to the right. In this manner, it resembles the development seen in *M. pulverulenta*. The larva of *M. picta* is conspicuously marked and similar to the larvae of *M. pulverulenta* and *M. assimilis*. I believe this to be adaptive and not sufficient reason in itself for placing *M. picta* close to *M. pulverulenta, M. assimilis,* and the Eurasian *M. pisi.* The male valves are most like *M. adjuncta,* but the female is distinctive in the development of the appendix bursae.

Specimens examined were taken May to September, there being at least two broods. The species is distributed from southern Canada to Washington in the West and Virginia in the East.

Specimens examined: 950 from the following provinces and states: Alberta, Manitoba, Nova Scotia, Ontario, Quebec, Saskatchewan, California, Idaho, Illinois, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, South Dakota, Utah, Vermont, Virginia, Washington, Wisconsin, and Wyoming. The species is an agricultural pest and is very common in the Canadian, Transitional and Upper Austral zones.

Melanchra pulverulenta Smith, new combination

(Figs. 38, 39, 99, 146)

Mamestra pulverulenta Smith, [1888] 1887. Proc. U.S. Natl. Mus., 10:468. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:86.
Type locality: Orono, Maine [USNM].
Mamestra assimilis sensu Smith, 1893. Bull. U.S. Natl. Mus., 44:121, *pulverulenta* in part.
Polia assimilis sensu Hampson, 1905. Cat. Phal. Brit. Mus., 5:158, *pulverulenta* in part.
Polia pulverulenta, McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Front uniformly clothed with a mixture of light and dark, bidentate and simple scales, no transverse band; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with divided anterior and posterior crests; tegula clothed with 3- and 4-dentate scales and a few hairs; abdomen with tufts on segments one through six, the tuft on four strongest; coremata absent; forewing with ground dark gray; ordinary lines and spots present; W-mark present.

Male genitalia: (Figs. 38, 39) T.L.M. slide no. 66.

Female genitalia: (Fig. 99) T.L.M. slide no. 232.

Alar expanse: 30–37 mm.

Food plant: Willow, aster, tamarack, western larch, lodgepole pine, Engelmann spruce and Douglas fir (Godfrey, 1972). I have found the larvae on *Larix laricina* (DuRoi) Koch and also reared from the egg on *L. laricina.*

In adult habitus, *M. pulverulenta* looks the most like the Eurasian *M. pisi,* but in male and female genitalia, *M. pisi* is closer to *M. assimilis. M. pulverulenta* has the largest appendix bursae of the three species. See *M. assimilis* for further discussion.

Specimens examined were taken June 1 to August 14. The species is distributed from Canada and Alaska south to California and Vermont.

Specimens examined: 320 from the following provinces and states: British Columbia, Manitoba, Newfoundland, Nova Scotia, Ontario, Quebec, Saskatchewan, Alaska, California, Colorado, Idaho, Maine, Minnesota, New York, Oregon, Vermont, Washington, and Wyoming. This species is found in the Canadian and Transitional zones.

Melanchra assimilis Morrison, new combination

(Figs. 40, 41, 100, 147)

Mamestra assimilis Morrison, 1874. Bull. Buffalo Soc. Nat. Sci., 2:113. Smith, 1893. Bull. U.S. Natl. Mus., 44:121. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:86.
Type locality: Massachusetts [MSU].
Polia assimilis, Hampson, 1905. Cat. Phal. Brit. Mus., 5:158, pl. 82, fig. 26. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Front uniformly clothed with black, bidentate scales; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax without anterior or posterior crests; abdomen with tufts on segments one through six, although they are often worn off on all but the freshest specimens, the tuft on four strongest; coremata absent; forewing ground black; wings with ordinary lines and spots present and finely outlined by intense black; W-mark present although often vague.

Male genitalia: (Figs. 40, 41) T.L.M. slide no. 142.

Female genitalia: (Fig. 100) T.L.M. slide no. 108.

Alar expanse: 30–39 mm.

Food plant: *Solidago*, *Pteris*, willow, buffaloberry, alder, white birch, white ash, *Betula populifolia* Marsh, *Osmunda cinnamonea* L., *Betula* sp., (Godfrey, 1972). *Verbascum thapsus* L., *Aster umbellatus* Mill., *Rubus ideaus* L., *Pteridium aquilinum* L., *Salix bebbiana* Sarg., *Myrica pennsylvanica* Loisel., *Larix laricina* DuRoi, *Chaemodaphne latifolia* (Ait.), *Ledum groenlandicum* Oeder, *Salix rigida* Muhl., *Myrica gale* L. All records from the present study consist of late instar larvae, field collected, and reared to adults.

M. assimilis, *M. pulverulenta,* and the Palearctic *M. pisi* form a very closely related species group similar in male and female genitalia, adult habitus, larval structure, and larval appearance. The larvae of *M. assimilis,* and *M. pulverulenta* are so similar that they should be reared to the adult stage for positive identification. Godfrey (1972, figs. 53 and 54) used the position of the ventral stripe on the eighth abdominal segment relative to setae SD-2 and the spiracle to separate the larvae. This was satisfactory for 80 percent of the caterpillars reared in 1977 in the Adirondacks of both *assimilis* (N = 200) and *M. pulverulenta* (N = 40). Wild collected larvae were more variable, and to be certain of identification they should be reared, because even with hypopharyngeal dissections the identification is doubtful. Adding to the possibility of confusion, *M. assimilis* was found to feed on *Larix laricina* DuRoi, a confirmed food plant for *M. pulverulenta*, both in the laboratory and in nature. There is a definite size difference between full-grown larvae. In *M. pulverulenta*, the full-grown length averages 26 mm, and in *M. assimilis* it averages 35–36 mm (Godfrey, 1972). These measurements by Godfrey were based on undistended larvae. As undistended larvae will vary in length depending on how contracted they are, the following measurements are for fully distended, preserved larvae which were reared from known females: *M. pulverulenta*, 33–36 mm (N = 10, $\bar{x}$ = 34.2); *M. assimilis*, 34–41 mm (N = 20, $\bar{x}$ = 40.3).

In the Adirondacks, Hamilton Co., New York, *M. assimilis* was generally distributed, but most common in bogs. Specimens examined were taken May 30 to July 31. The species is distributed from Canada south to Washington in the West and Pennsylvania in the East.

Specimens examined: 330 from the following provinces and states: Alberta, British Columbia, Manitoba, Nova Scotia, Ontario, Quebec, Connecticut, Idaho, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New York, Pennsylvania, Virginia, Washington, and Wisconsin.

Spiramater, new genus

(Figs. 5, 6, 44, 101, 148)

Type-species: *Hadena lutra* Guenée, 1852. Hist. Natl. Insectes (Lépid.) 6:94.

Head with appressed simple scales on lower front, middle front and vertex with longer, upright, bidentate scales; tongue well developed; labial palpi upcurved to lower fourth of front, loosely scaled below, second segment twice as long as first and three times as long as third, apex of third acute; antennae simple, segments unisetose on each side; scape as wide as long, bulbous; epiphysis nearly half the length of fore tibia; tarsi with three rows of spinules; abdominal tufts present; coremata absent.

Forewing average length to width ratio 2.2:1; margin weakly crenulate; 12 veins reaching margin; accessory cell present; R_3&R_4 stalked for one-third distance of accessory cell. Hindwing average length to width ratio 1.5:1; margin weakly crenulate; 9 veins present; M_2 located at lower one-third distance of M_3 to M_1; R & M_1 and M_3 & Cul not stalked; Cu_2 arising from three-fourths the length of cell.

Male genitalia: valve with costa strengthened, heavily sclerotized, tubular, and projecting distally; fixed penicular hairs present; clavus lacking a projection; vesica elongate, spiralling, with bulbed cornuti or single bulbed cornutus.

Female genitalia: bursa constricted at apex, with four bandlike signa; appendix directed to left from point of juncture of ductus bursae and constricted portion of bursa; appendix spiralling, as long as bursa; ductus seminalis arising from apex of appendix.

Spiramater differs from *Lacanobia* as follows: In the female genitalia, the appendix is long and spiralling in *Spiramater;* that of *Lacanobia* is a tight, one-loop coil. In the male genitalia, the sacculus lacks processes in *Spiramater*, whereas that of *Lacanobia* bears an outwardly directed process. A free clavus is absent in *Spiramater*, whereas in *Lacanobia* a free clavus is present. The larvae of *Spiramater* have the second inner ridge of the mandible strongly diverging; those of *Lacanobia* have the second ridge parallel with the first.

The relationship of *Spiramater* to *Lacanobia* and other genera is uncertain because of the elaborate and divergent type of male genitalia. Without a study of the female genitalia, the relationship of *S. grandis* and *S. lutra* might easily have been overlooked. The genus may not be derived from the same phyletic line as *Lacanobia*, but may have arisen directly from a *Pachetra*-like ancestral type. Despite the fact that *Spiramater* is apparently absent in the Palearctic, it does not appear to be a recently derived genus. The variability of the male genitalia, as evidenced by the highly modified valves, suggests an element older than *Lacanobia*.

This variability, coupled with a similarity in female genitalia and adult habitus to *Pachetra sagittigera*, suggests a relationship to *Melanchra* which also apparently arose from a *Pachetra*-like ancestor. *Spiramater* differs from *Melanchra* in the following respects: In the male genitalia, *Spiramater* has bulbed cornuti and *Melanchra* does not. *Spiramater* lacks an aedeagal projection and *Melanchra* possesses a projection. *Spiramater* lacks a projection of the costa of the valves and *Melanchra* has a projection. *Spiramater* has a long, spiralling vesica, whereas *Melanchra* has a comparatively simple vesica. In the female genitalia, *Spiramater* has a long, spiralling appendix directed to the left, whereas *Melanchra* has no appendix or only a short stub directed to the right.

Two species of *Spiramater* are known to occur within the geographical area covered in this paper. *S. lutra* and *S. grandis* are both polyphagous, but trees are the most frequently used food plants. I have collected the larva of *S. lutra* on *Salix rigida* Muhl. and *Vaccinium myrtilloides* Michx. in the late afternoon.

KEY TO THE SPECIES OF *SPIRAMATER* BASED UPON THE ADULT MACULATION

1. Forewing without median dash .... *lutra*
— Forewing with median dash .... *grandis*

KEY TO THE SPECIES OF *SPIRAMATER* BASED UPON THE MALE GENITALIA

1. Cucullus elongate, hardly wider than "neck" .... *lutra*
— Cucullus short, circular, much wider than "neck" .... *grandis*

KEY TO THE SPECIES OF *SPIRAMATER* BASED UPON THE FEMALE GENITALIA

1. Appendix weakly spiralling, longer than bursa .... *lutra*
— Appendix tightly coiled, shorter than bursa .... *grandis*

Spiramater lutra Guenée, new combination

(Figs. 6, 42, 43, 101, 149)

Hadena lutra Guenée, 1852. Hist. Nat. Insectes (Lépid.) 6:94.
Type locality: "Nouvelle-Hollande, M. N." The moth was actually from North America (Tams, 1926). [PM].
Mamestra cristifera, *sensu* Smith, 1893. Bull U.S. Natl. Mus., 44:121.
Mamestra rufula Morrison, 1875. Proc. Acad. Nat. Sci. Philadelphia, 62.
Type locality: Massachusetts, New York, Illinois, Missouri, and Indiana [not determined].
Mamestra lubens Grote, 1889. Trans. Am. Ent. Soc., 5:113.
Type locality: "Canada, Eastern and Middle States" [BM(NH)].
Eumichtis sepultrix, *sensu* Hampson, 1906. Cat. Phal. Brit. Mus., 6:333.
Polia glaucopis Hampson, 1905. Cat. Phal. Brit. Mus., 5:106, pl. 81, fig. 6.
Type locality: Vancouver Island [BM(NH)].
Polia lutra, Tams, 1926. Encyclopédie Entomologique, Série B Mémoires et Notes III, Lepidoptéra 1:183-5.
Mamestra lutra, Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:86.
Polia lutra, McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Front with uniform mixture of light and dark bidentate scales, no transverse band; palpi upcurved nearly to middle of front; male antennae simple, unisetose on each side; female similar, but with shorter setae; thorax with a weak, divided anterior crest and a divided posterior crest; tegula clothed with 3-, 4-, and 5-dentate scales and considerable hair; abdomen with tufts on first four or five segments, tufts on three and four largest; coremata absent; forewing ground dull gray with a rust tinge basally and along subterminal line; W-mark present; basal and median dashes absent.

Male genitalia: (Figs. 42, 43) T.L.M. slide no. 231.

Female genitalia: (Fig. 101) T.L.M. slide no. 92.

Alar expanse: 33–48 mm.

Food plant: Huckleberry, sumach, birch, alder, vine maple (*Acer circinatum*), willow, spiraea (*Spiraea douglasi*), corn, *Plantago*, Douglas fir, red alder, buffaloberry, western hemlock, western red cedar, western white birch, arbutus, maple, tamarack, white birch, speckled alder, Garry oak, grand fir, Sitka spruce, white spruce, lodgepole pine, chokecherry, hazel, trembling aspen, amabilis fir, dwarf birch, broad-leaf maple, silver poplar, gooseberry, *Cornus racemosa* Lam., (Godfrey, 1972). *Salix rigida* Muhl., *Salix bebbiana* Sarg., *Alnus rugosa* DuRoi, *Aster umbellatus* Mill., and *Vaccinium myrtilloides* Michx., [TLM].

Many past records refer to this species as "*lubens* Grote" or "*cristifera* Walker"; Smith, 1891, illustrates *S. lutra* as "*cristifera*" in his revision of *Mamestra*. When the species was described, Guenée erroneously cited it as being from "Nouvelle-Hollande" and was not considered by subsequent workers; Tams (1926) examined the type and indicated the synonymy. Hampson's *glaucopis* was described from Vancouver Island as a full species. Hampson synonymized *Hadena lutra* Gn. with *Eumichtis sepultrix* Gn. Tams, 1926, pointed this out and Viette, 1951, illustrated the male genitalia of the type.

In treating *glaucopis* as a subspecies, McDunnough (1938) must have been considering the slightly larger, lighter specimens of *S. lutra* from the East (esp. New Jersey). The type of *S. lutra* resembles a specimen from the East (wing expanse given as 40 mm in type description). The larger eastern specimens represent the end of two clines for size and color.

Specimens examined were taken May 17 to August 4. The species is distributed from Canada south to California in the West and North Carolina in the East.

Specimens examined: 610 from the following provinces and states: British Columbia, Manitoba, Newfoundland, Nova Scotia, Ontario, Quebec, California, Colorado, Connecticut, Idaho, Indiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New York, North Carolina, North Dakota, Oregon, Pennsylvania, South Dakota, Vermont, Virginia, Wisconsin, Wyoming. The species occurs in the Upper Austral, Transitional, and Canadian life zones.

Spiramater grandis Guenée, new combination

(Figs. 5, 44, 45, 102, 148)

Hadena grandis Boisduval, 1840. Gen. Ind. Meth., 120, No. 950, a nomen nudum.
Type locality: "Reg. Pol." [not determined].
Hadena grandis Guenée, 1841. Ann. Soc. Ent. France, 10:244, a nomen nudum.
Hadena grandis Guenée, 1852. Hist. Nat. Insectes (Lépid.) 2:105 pl. 8, fig. 10.
Type locality: "Etat de New-Yorck [probably Trenton Falls]. Coll. Dbday. Laponie et Groenland. Coll. Bdv." [BM(NH)].
Xylophasia libera Walker, 1856. List Spec. Lep. Ins. Coll. Brit. Mus., 9:179.
Type locality: New York [BM(NH)].
Mamestra grandis, Smith, 1893. Bull. U.S. Natl. Mus., 44:118. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:83.
Polia grandis, Hampson, 1905. Cat. Phal. Brit. Mus., 5:94, pl. 80, fig. 30. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front with incomplete, broken-in-middle, transverse band of bidentate scales; palpi upcurved nearly to middle of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with divided anterior and posterior crests; tegula clothed with 4- and 5-dentate scales and considerable hair; abdomen with tufts on first four segments, tufts on three and four largest and subequal; coremata absent; forewing ground reddish-brown; ordinary lines and spots present; W-mark present; both basal and median dash present.

Male genitalia: (Figs. 44, 45) T.L.M. slide no. 65.

Female genitalia: (Fig. 102) T.L.M. slide no. 100.

Alar expanse: 31–44 mm.

Food plant: *Arctium lappa* L., willow, linden, blueberry, *Alnus* spp., *Populus tremuloides* Michx., (Godfrey, 1972).

LECTOTYPE: present designation. A ♀ specimen in the British Museum (Natural History), having descended from the Boisduval and Oberthür collections, bearing the following labels: 1) *Grandis*, B.; 2) Ex Musaeo Dris Boisduval; 3) Ex Oberthür Coll., Brit. Mus. 1927 3.; 4) Fig. par J. Culot Noc et Géom d'Europe, Pl. 28 Fig. 18; 5) *grandis* Laponie [BM(NH)].

The relationship of *S. grandis* and *S. lutra* to one another is apparent from the similar female genitalia. They also share similar wing shapes, abdominal tufting, presence of bulbed cornuti, and presence of fixed penicular hairs. The male valves and unci are markedly dissimilar. The larvae show a relationship as Godfrey (1972, p. 42) notes in his discussion of *S. grandis*: "Hypopharyngeal complex (fig. 83): Very similar to that of *Polia lutra* (Guenée), although Lps-1 slightly stouter and larger. Mandible (fig. 84): Similar to that of *P. lutra*, but inner tooth slightly stouter."

Specimens examined were taken May 28 to July 16. The species is distributed from Canada south to Colorado and Virginia.

Specimens examined: 280 from the following provinces and states: Alberta, British Columbia, Manitoba, Nova Scotia, Ontario, Quebec, Colorado, Connecticut, Idaho, Illinois, Maine, Massachusetts, Michigan, Minnesota, Montana, New Hampshire, New Jersey, New York, North Dakota, Pennsylvania, Vermont, Virginia, and Wisconsin. The species is common in collections and occurs in the Transitional and Canadian life zones.

Lacanobia Billberg

(Figs. 9, 46, 103, 150)

Lacanobia Billberg, 1820. Enumerato Insect Mus. G. J. Billberg :87.

Type-species: *Phalaena w-latinum* Hufnagel, 1766. Berlin Mag., 3(3):292, by subsequent designation by Tams, 1939. Entomologist, 72:139.

Diataraxia Hübner, [1821] 1816. Verz. bekannter Schmett. :219.

Type-species: *Noctua splendens* Hübner, [1808]. Samml. eur. Schmett. 4: pl. 85, fig. 400, by subsequent designation by Viette, 1951. Bull. Mens. Soc. Linn. Lyon, 20:161.

Peuciphila Hampson, 1909. Trans. Ent. Soc. Lond., 1909:461.

Type-species: *Peucephila essoni* Hampson, 1909. Trans. Ent. Soc. Lond., 1909:461, pl. 16, by original designation.

Head densely clothed with upright, simple and bidentate scales; tongue well developed; labial palpi upcurved to lower fourth of front, loosely scaled below, second segment twice as long as first and four times as long as third, third acute at apex; antennae simple, ciliate, segments unisetose on each side; scape as wide as long, bulbous; epiphysis nearly half the length of fore tibia; tarsi with three rows of spinules; abdominal tufts variable.

Forewing average length to width ratio 2.1:1; margin weakly crenulate; 12 veins present; third anal vein present at base; accessory cell present; R_3&$_4$ stalked for one-third distance to apex; M_3 arises midway between Cu_1 & M_2; M_1 from distal third of accessory cell. Hindwing average length to width ratio 1.5:1; margin weakly crenulate; 9 veins present; M_2 located nearly midway between M_3 & M_1; R & M_1 and M_3 & Cu_1 not stalked; Cu_2 arises from three-fourths the length of the cell.

Male genitalia: valve with strengthened, heavily sclerotized, tubular costa; free clavus present, papilla-like, and bearing setae; fixed penicular hairs present; sacculus with outward projection; digitus present; cucullus variable, frequently acute; vesica with bulbed cornutus at base and raised cornuti toward apex; vesica a tight coil.

Female genitalia: Four bandlike signa; appendix directed to the left from juncture of ductus bursae and the constricted apex of bursa; appendix a tight, one-loop coil; ductus seminalis arising from apex of appendix.

Four North American species are recognized as belonging to this genus. They were all placed in *Polia* by McDunnough. The genotype, *L. w-latinum*, has been placed in the "collective genus" *Mamestra* by Boursin (1964) and Dufay (1975). *Lacanobia* was resurrected by Fletcher (1972).

Lacanobia w-latinum, Tams' choice of a genotype, is an isolated element in the genus. The appendix bursae is a simple pouch in *L. w-latinum,* whereas it is coiled in the other species. The male vesica has a bulbed cornutus on a basal fork, typical of most *Lacanobia* species, but it also possesses a strengthening arch not seen among other species. Furthermore, the raised distal cornuti, composed of a cluster of spines, so characteristic of most *Lacanobia,* is absent in *L. w-latinum.* The male valves lack the processes frequently seen in the other species, but heavily sclerotized areas, bases of processes, are in the same location.

Adult habitus, including maculation, possession of a W-mark, basal, and median dash, place it with the Palearctic *L. thalassina* Hufnagel and the Nearctic *L. nevadae* group. The female bursa has four bandlike signa and the appendix is directed to the left of the ductus bursa. The type-species of *Diataraxia* Hübner, [1821] 1816, *Noctua splendens* Hufnagel, 1766, is well within the variation seen in the genus *Lacanobia.*

Lacanobia is close to *Melanchra* and differs by the presence of a free clavus, papilla-like and setose. In the Palearctic *Lacanobia illoba* Butler, this free clavus has degenerated to a mere pad of setae at the base of the valve. This is comparable to the Nearctic *L. subjuncta* in which the free clavus has become less heavily sclerotized and more blunt. Further differences include: *Melanchra* has an aedeagal projection and the aedeagus of *Lacanobia* lacks a projection. *Melanchra* has a simple vesica with distal cornuti; whereas that of *Lacanobia* has one or two bulbed cornuti and distal cornuti. *Melanchra* lacks an appendix bursae or has an appendix directed to the right; the appendix of *Lacanobia* species are directed to the left.

KEY TO THE SPECIES OF *LACANOBIA* BASED UPON THE ADULT MACULATION

1. Median dash present, complete and prominent . . . . *subjuncta*
— Median dash absent or only represented weakly on basal half 2

2. W-mark not edged with black wedges; forewing dull gray-brown and uniform . . . . *radix*
— W-mark with black wedges proximally; wing conspicuously patterned with dark and light browns 3

3. Light patch above basal dash running out into costa along two-thirds the entire costal length . . . . *atlantica*
Light patch above basal dash abruptly different from color along costa beyond antemedial line . . . . *nevadae*

KEY TO THE SPECIES OF *LACANOBIA* BASED UPON THE MALE GENITALIA

1. Cucullus well developed and rounded . . . . *subjuncta*
— Cucullus apparently absent 2

2. Process of sacculus (psa, fig. 53) as wide at base as at apex . . . . *radix*
— Process of sacculus tapering abruptly to a blunt point 3

3. Process of sacculus with base about one-tenth entire length of valve . . . . *nevadae*
— Process of sacculus with a base about one-quarter entire length of valve . . . . *atlantica*

KEY TO THE SPECIES OF *LACANOBIA* BASED UPON THE FEMALE GENITALIA

1. Appendix nearly as large as bursa, directed ventrally . . . . *radix*
— Appendix much smaller than bursa and directed laterally to the right 2

2. Bursa tapering posteriorly to join ductus bursae; appendix almost half the size of bursa . . . . *subjuncta*
— Bursa abruptly constricted at juncture with ductus bursae; appendix about one-third or one-fourth the size of bursa 3

3. Appendix one-fourth or less the size of bursa . . . . *atlantica*
— Appendix one-third the size of bursa . . . . *nevadae*

Lacanobia subjuncta Grote & Robinson, new combination

(Figs. 46, 47, 103, 150, 151)

Hadena subjuncta Grote & Robinson. 1868. Trans. Am. Ent. Soc., 2:198, pl. 3, fig. 71.

Type locality: "Atlantic district" [represented by an illustration, deposition not determined].

Mamestra subjuncta, Smith, 1893. Bull. U.S. Natl. Mus., 44:118. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Agric. Exp. Sta. Mem., 329:83.

Polia subjuncta, Hampson, 1905. Cat. Phal. Brit. Mus., 5:97, pl. 80, fig. 32. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Polia subjuncta eleanora Barnes & McDunnough, 1918. Contri. Nat. Hist. Lep. N. A., 4:95, pl. 16, fig. 1.
Type locality: Nellie, Palomar Mt., San Diego Co., California [USNM].

Front with black transverse band consisting of simple and bidentate scales; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with prominent, divided anterior crest, posterior crest absent; abdomen with four or five tufts, three and four the largest and subequal; coremata absent; forewing with ground gray-brown with a reddish cast, variable, southwestern specimens are larger and more gray; basal and median dash present; W-mark present.

Male genitalia: (Figs. 46, 47) T.L.M. slide no. 226.

Female genitalia: (Fig. 103) T.L.M. slide no. 63.

Alar expanse: 34–50 mm.

Food plant: Cabbage, Cruciferae, peach, *Vaccinium canadense*, *V. corymbosum*, *V. pennsylvanicum*, willow, alder, maple, asparagus, strawberry, corn, violet, potato, *Taraxacum officinale* (Godfrey, 1972).

Lacanobia consists of two groups: those species with rounded cuculli and those with acutely pointed cuculli. *L. subjuncta* represents the extreme of the former group, having a very large, almost circular cucullus. Based on the male genitalia, *L. subjuncta* goes with the Eurasian *L. splendens* Hübner and *L. oleracea* L., both treated as species of *Mamestra* by Boursin, 1964, and Dufay, 1975. In adult habitus, *L. subjuncta* resembles the Palearctic *L. w-latinum*. This intermingling of characters serves to unify the elements of the genus. The basal lobes of the vesica are present in *L. subjuncta*, but they lack the bulbed cornuti found in most species of *Lacanobia*. *L. subjuncta* can be distinguished from the other Nearctic species of *Lacanobia* by the presence of a complete median dash on the forewing.

Specimens examined were taken in May through June and again in July through August (two broods). The species is distributed from Canada south to California and Arizona in the West and Virginia in the East.

Specimens examined: 1100. From the following provinces and states: Alberta, British Columbia, Manitoba, Nova Scotia, Ontario, Quebec, Saskatchewan, Arizona, California, Colorado, Idaho, Indiana, Maine, Massachusetts, Minnesota, Montana, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Pennsylvania, Utah, Vermont, Virginia, Washington, and Wyoming. This species is an agricultural pest.

Lacanobia nevadae **Grote, new combination**

(Figs. 48, 49, 104, 152 and Map 4)

Mamestra nevadae Grote, 1876. Bull. Buffalo Soc. Nat. Sci., 3:84. Smith, 1893. Bull. U.S. Natl. Mus., 44:118. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Agric. Exp. Sta. Mem., 329:87.
Type locality: Sierra Nevada, California [BM(NH)].

Mamestra canadensis Smith, [1888] 1887. Proc. U.S. Natl. Mus., 10:464. Smith, 1893. Bull. U.S. Natl. Mus., 44:118.
Type locality: New Brunswick [not determined].

Polia nevadae, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:98, pl. 81, fig. 1. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

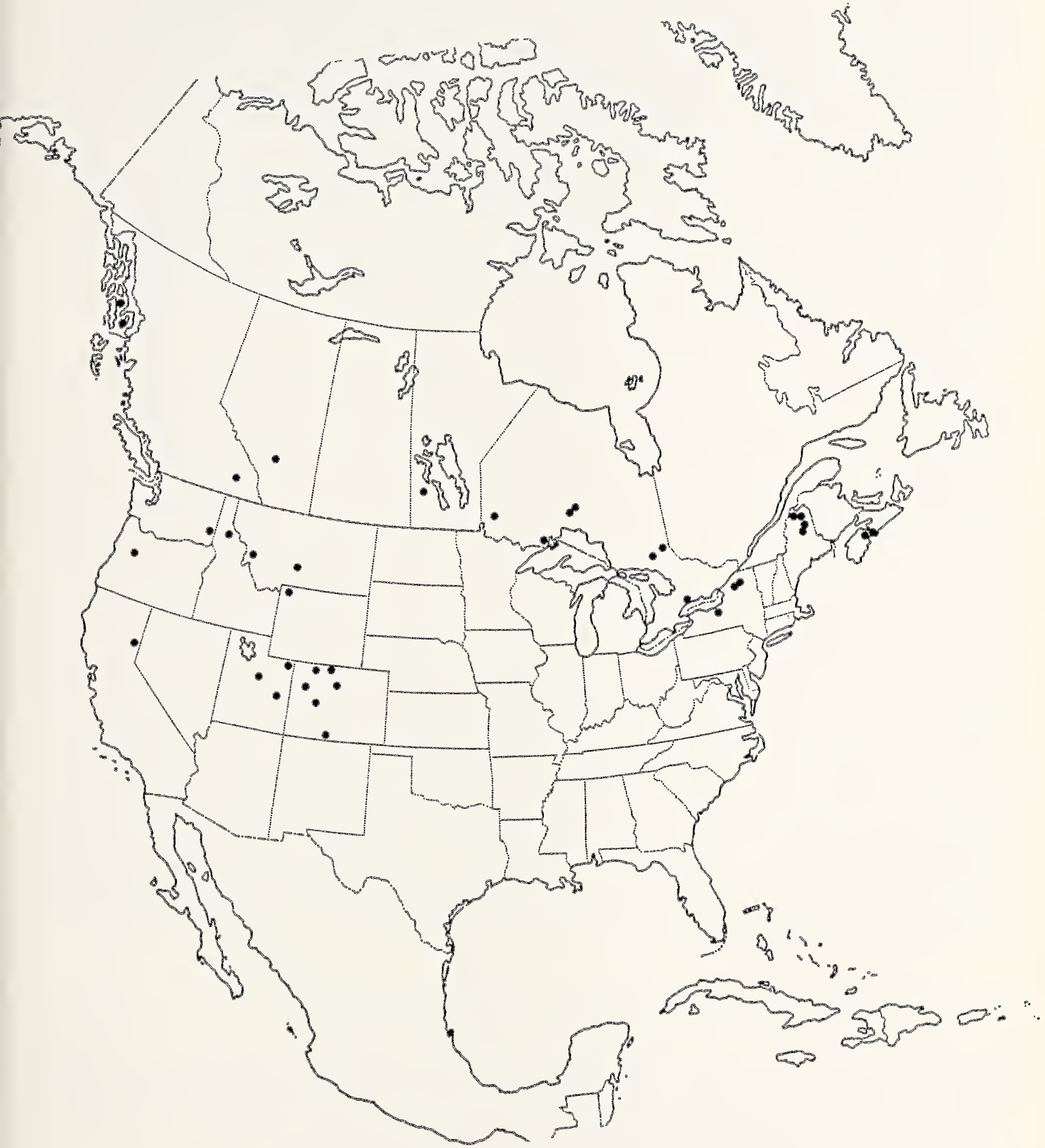
Front with partial transverse band of mostly bidentate scales; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with divided anterior and posterior crests; tegula clothed with bidentate scales and hair; abdomen with tufts on first three segments, the tuft on segment two largest; coremata absent; forewing with ground reddish-brown; W-mark present; reniform filled with dark on lower half.

Male genitalia: (Figs. 48, 49) T.L.M. slide no. 174.

Female genitalia: (Fig. 104) T.L.M. slide no. 16.

Alar expanse: 35–43 mm.

Food plant: Tamarack, Juniper, *Betula populifolia* Marsh., (Godfrey, 1972).



Map 4.—Geographical distribution of *Lacanobia nevadae* Grote.

L. nevadae is close to *L. atlantica* and the Palearctic *L. thalassina*. Butler (1889) synonymized *L. nevadae* with *L. thalassina*, but according to Smith (1893, p. 8) Butler did not consider the genitalia: ". . . caused by the failure to compare structural characters and relying only on an apparent, superficial resemblance." This shows how similar in maculation the two species are. However, *L. thalassina* is actually closer in genitalia to *L. atlantica*. *L. thalassina* lacks the narrow digitus of *L. nevadae* and *L. thalassina* and *L. atlantica* have a large process arising from the sacculus; *L. nevadae* has only a small process. Differences between *L. atlantica* and *L. nevadae* are given in the keys; see also discussion under *L. atlantica*.

Mamestra canadensis Smith was treated by Hampson, 1905, as a synonym of *L. nevadae;* Smith, 1907, did not accept the synonymy, but stated that *canadensis* might be a race of *nevadae* and it was regarded as a subspecies of *L. nevadae* by Barnes & McDunnough (1917). Smith, sometime between 1888 and 1892, learned the identity of the true *L. nevadae* Grote, but (1893) considered it distinct from *canadensis*. To quote from his catalog where he was writing about *L. nevadae*: "This seems a good species, almost midway between *subjuncta* and *atlantica*. I had not seen it before, the specimen in the Edwards' collection being erroneously named." Smith (1887[1888]) examined a specimen misidentified as *Mamestra nevadae* in the Edwards' collection; the specimen was an example of *Hadena curvata*, now *Aseptis binotata* race *curvata* Grt.

Specimens examined were taken May 22 to August 7.

Specimens examined: 59. ALBERTA: Calgary, June 16–23 [CAS]; Calgary, June 28, 1883 [AMNH]; Calgary, May 27, 1902 and July 24, 1889 F. H. Wolley Dod [USNM]; Calgary, June 16–23 [USNM]. BRITISH COLUMBIA: Kaslo, July 12 [AMNH]; Kaslo, July 7, 1909 and July 8–15 [USNM]; Robson, June 20 and 26, 1936 H. R. Foxlee [JGF]; Robson, June 25 and July 7, 1938 O. Buchholz [AMNH]. MANITOBA: Riding Mts., June 8, 1936 J. P. May [JGF]. NOVA SCOTIA: Armdale, Halifax Co., June 24, 1961 D. C. Ferguson [USNM]; West Dover, Halifax Co., July 15 and 24, 1968 D. C. Ferguson [USNM]. ONTARIO: Kenora, Rt. 17, June 25, 1977 L. P. Grey [TLM]; Charlton, July 12 O. Buchholz [AMNH]; Geraldton, June 30, 1956 and June 13, 19, 1957 O. Buchholz [AMNH]; Geraldton, July 13, 1956 J. C. E. Riotte [AMNH]; Hymers, June 24–30 [USNM]; Nakina, June 28, 1960 J. C. E. Riotte [AMNH]; Sudbury, July 18, 1960 O. Buchholz [AMNH]; Toronto, June 23 [USNM]. QUEBEC: Meach Lake, Ottawa Co., July 24–31 [USNM]. ALASKA: Ketchikan, June 24–30 [USNM]; 45 mi. S. Petersburg, July 4, 1962 [DAVIS]. CALIFORNIA: Johnsville, Plumas Co., July 20, 1964 H. Pini [DAVIS]. COLORADO: Trujillo Meadow Campground, 3 mi. N. Combres, Conejos Co., July 9, 1967 F. & P. Rindge [AMNH]; 5 mi. SW. Fraser, Grand Co., 8,900′, July 27, 1967 F. & P. Rindge [AMNH]; Gould, Jackson Co., 9,000′, July 11, 1966 F. & P. Rindge [AMNH]; 4 mi. SW. Aspen, Pitkin Co., June 16, 1964 P. Feinsinger [DAVIS]; 10 mi. SE. Steamboat Springs, Routt Co., 8,200′, July 28, 1962 Bauer & Trenam [DAVIS]; Valley View Lodge, 10 mi. S. Steamboat Springs, Routt Co., July 14, 1956 F. & P. Rindge [AMNH]; Glenwood Springs, July 24–30 [USNM]. IDAHO: Wallace, July 7, 1940 O. Huellemann [AMNH]. MAINE: Allagash, August 3, 1922 [USNM]; Masardis, August 7 O. Buchholz [AMNH]; Oxbow, July 15 [USNM]; St. Francais, July 12 [USNM]; Sinclair, August 4 [USNM]. MONTANA: Half Moon Park, 6,500′, Crazy Mts., Sweet Grass Co., July 10, 1969 J. G. Franclemont [JGF]; Hamilton, May 22, 1929 [CAS]. NEW YORK: Saranac Lake, July 1886 [NYSM]; Franklin Co., C. S. McKnight [USNM]; Geneva, Chapman & Link [CU]. OREGON: Lava Lake, 3,400′, Linn Co., July 12, 1976 T. L. McCabe [TLM]. UTAH: Reeder Canyon, 7,000′, nr. Jose Vly. Res., Monti La Sal Nat. Frst., Emery Co., July 11, 1971 D. C. Ferguson [USNM]; 17 mi. E. Mayfield, 10,200′, Sanpete Co., July 19, 1960 F. & P. Rindge [AMNH]; Kaler Hollow Camp, 22 mi. NW. Vernal, Uintah, Co., July 24, 1963 F. & P. Rindge [AMNH]. WASHINGTON: Pullman, July 12, 1930 J. F. G. Clarke [JGF]. WYOMING: Yellowstone Nat. Pk., 7,800′, July 10, 1955 [AMNH].

Lacanobia atlantica Grote, new combination

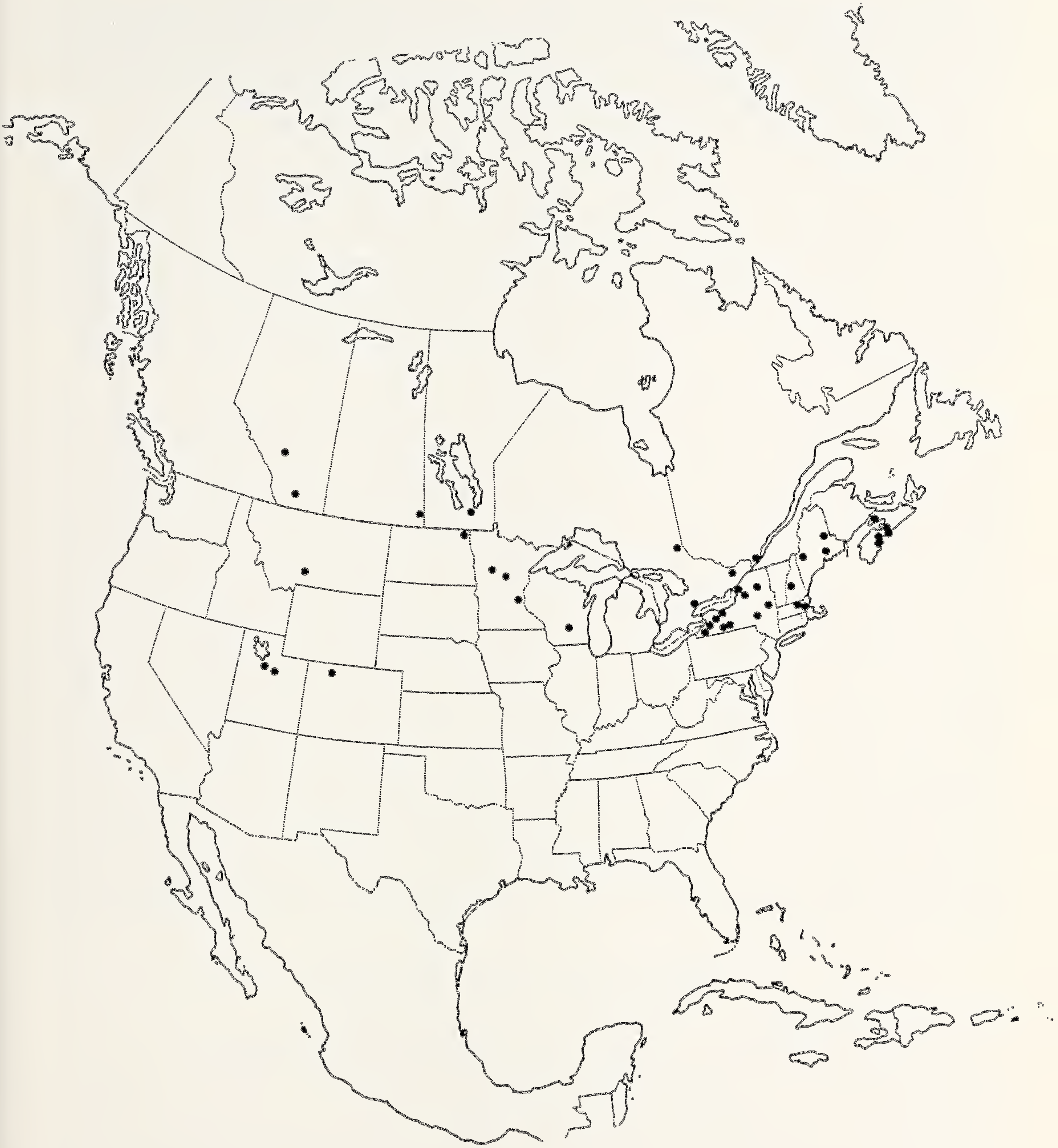
(Figs. 9, 50, 51, 105, 153 and Map 5)

Hadena w-latinum variety "A" Guenée, 1852. Sp. Gen. Noc., 2:105.

Mamestra atlantica Grote, 1874. Bull. Buffalo Soc. Nat. Sci., 2:12. Smith, 1893. Bull. U.S. Natl. Mus., 44:117. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:86–7.
Type locality: [Atlantic States] [BM(NH)].

Mamestra dissimilis var. *discolor* Speyer, 1875. Stettiner Ent. Zeitung, 36:142.
Type locality: "Beverly in Massachusetts" [not determined].

Polia atlantica, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:133, pl. 81, fig. 26. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.



Map 5.—Geographical distribution of *Lacanobia atlantica* Grote.

Front clothed with mixture of dark and light tipped, 2- and 3-dentate scales, without transverse band; palpi upcurved nearly to middle of front; male antennae simple, segments unisetose on each side, female antennae similar, but with shorter setae; thorax without anterior or posterior crests; tegula clothed with 2-and 3-dentate scales and considerable hair; abdominal tufts very weak on first three segments; coremata absent; forewing with ground reddish-brown; basal dash present; W-mark present; reniform filled with dark on lower half.

Male genitalia: (Figs. 50, 51) T.L.M. slide no. 75.

Female genitalia: (Fig. 105) T.L.M. slide no. 89.

Alar expanse: 30–42 mm.

Food plant: *Lonicera caprifolium*, *Plantago*, *Taraxacum*, *Quercus*, *Salix*, *Populus*, clover, alfalfa (Godfrey, 1972).

L. atlantica has been treated as a synonym of Eurasian *L. suasa* Schiffermüller (= *L. dissimilis* Knoch) by Butler (1889). It is readily distinguishable, even in maculation, from *L. suasa*. Later authors may have been following Butler's lead in treating it as a synonym of *L. suasa*. *L. atlantica* is frequently mistaken for *L. nevadae*, especially in the West. In maculation, the adults are separable by the extent of light brown along the costa (see key to adults), *L. nevadae* has only a basal patch. The larvae of the two species are also similar. *L. atlantica* larva can be distinguished from *L. nevadae* by its shorter and stouter first segment of the labial palpus (Godfrey, 1972).

Specimens examined were taken May 13 to August 28.

Specimens examined: 72. ALBERTA: Calgary, June 24–30, July 26 [USNM]; Sunnydale, May 30 & June 19, 1943 P. F. Bruggemann [AMNH]; Lethbridge, July 1945 G. A. Hobbs [AMNH]. MANITOBA: The Pas, July 16, 1954 W. Krivda [AMNH]; Winnipeg, June 24–30 [USNM]. NOVA SCOTIA: Amherst, Cumberland Co., June 14, 1962 D. C. Ferguson [USNM]; Green Bay, Larimer Co., July 1, 1956 D. C. Ferguson [USNM]; Armdale, June 20, 1945, August 10, 1946, June 13 & July 20, 1947 D. C. Ferguson [USNM]; Brooklyn, Hants Co., July 23, 1972 D. C. Ferguson [USNM]; Truro, June 30, 1925 [USNM]; Halifax, July 15, 1944 D. C. Ferguson [USNM]. ONTARIO: Charlton, June 21 O. Buchholz [AMNH]; One-Sided Lake, July 7, 1960 M. R. MacKay [CNC]; Ottawa [AMNH]; Toronto, June 18 O. Buchholz [AMNH]. QUEBEC: Meach Lake, Ottawa Co., May 8–15 [USNM]; Montreal, June 19 O. Buchholz. SASKATCHEWAN: Redvers, A. J. Croker [USNM]. COLORADO: Vly. View Lodge, 7,600′, 10 mi. S. Steamboat Springs, Routt Co., July 13, 1957 F. Rindge [AMNH]. MAINE: Orono [USNM]; Enfield, Penobscot Co., July 18, 1953 L. P. Grey [AMNH]; Rangeley, June 23, 1938 V. H. Dos Passos [AMNH]. MASSACHUSETTS: Cambridge, August 3, 1874 [NYSM]; Concord, July 8, 1913 W. Reiff [USNM]. MINNESOTA: Tamarac Lake, Becker Co., June 29, 1975, July 7, 1973 R. J. Minch [TLM]; 3 mi. E. Ogema, Becker Co., June 23, 1974, July 7, 1973 P. K. Lago [PKL & TLM]; Brainerd, May 18, 1934 (reared) H. Knutson [MINN]; St. Paul, August 28, 1927 C. T. Schmidt [MINN]. MONTANA: Bozeman, July 22, 1908 & August 3, 1907 [AMNH]. NEW HAMPSHIRE: Claremont, June 20, 1908 [USNM]. NEW YORK: Lewis Co., July 24, 1885 W. W. Hill [NYSM]; Adirondacks [USNM]; Addison [USNM]; Clayton [AMNH]; Concord, August 10, 1940 [AMNH]; Horseheads, June 3, 1941 L. R. Ruppert [AMNH]; Lakeville, August 4–26, 1927 E. A. Maynard [NYSM]; Oneonta, August 15, 1894 [AMNH]; Sardinia, July 26, 1941 L. R. Ruppert [AMNH]; Schenectady, July 25, 1876 J. Lintner [NYSM]; Schenectady, June 10, 1876 J. Lintner [NYSM]; Rochester, July 21 & August 1, 19, 1931 E. A. Maynard [NYSM]; McLean Bogs, Tompkins Co., May 23, 1946 J. G. Franclemont [JGF]. NORTH DAKOTA: Pembina Co., T161N R56W S22, July 2, 1975 P. K. Lago [PKL]. UTAH: Provo, July 4, 1912 T. Spalding [USNM]; Vineyard, August 21, 1912 & May 3, 1923 T. Spalding [USNM]. WISCONSIN: Madison, June 4, 1929 M. H. Doner [USNM].

Lacanobia radix Walker, new combination

(Figs. 52, 53, 106, 154 and Map 6)

Agrotis radix Walker, [1857] 1856. List. Spec. Lep. Ins. Coll. Brit. Mus., 10:332.

Type locality: "St. Martin's Falls, Albany River, Hudson's Bay" & "Nova Scotia" [BM(NH)].

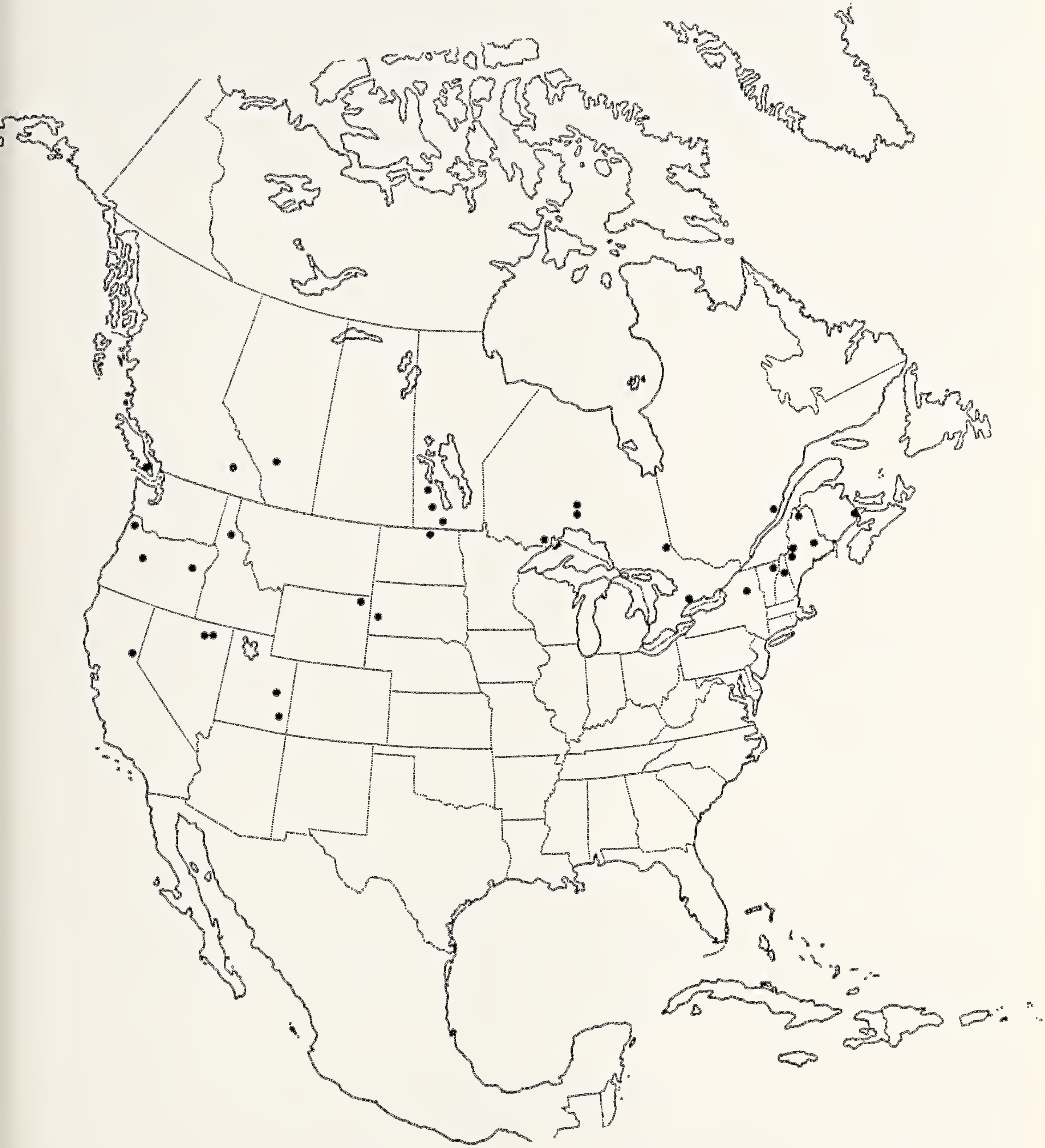
Mamestra dimmocki Grote, 1875. Proc. Acad. Nat. Sci. Philadelphia, 420.

Type locality: White Mts., New Hampshire [BM(NH)].

Mamestra desperata Smith, 1891. Proc. U.S. Natl. Mus., 14:221.

Type locality: New Hampshire, Maine, Sierra Nevada, California [not determined].

Mamestra radix, Smith, 1893. Bull. U.S. Natl. Mus., 44:117–8. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:87.



Map 6.—Geographical distribution of *Lacanobia radix* Walker.

Polia radix, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:132, pl. 81, fig. 25. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front with a mixture of light and dark, white-tipped, simple or bidentate, narrow scales; palpi upcurved to middle of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with weak divided anterior and posterior crests; tegula clothed with narrow 2- and 3-dentate scales and considerable hair; abdomen with weak tufts on first three segments, tufts on two and three subequal; eoremata absent; forewing ground lead-gray often with a reddish basal dash present; median dash absent; W-mark present.

Male genitalia: (Figs. 52, 53) T.L.M. slide no. 263.

Female genitalia: (Fig. 106) T.L.M. slide no. 175.

Alar expanse: 32–38 mm.

Food plant: willow, white birch, alder, grass, clover, and dandelion (Godfrey, 1972). *Salix petiolaris sensu* Am. auth., *Alnus rugosa* DuRoi, *Betula papyrifera* Marsh. [TLM].

L. radix and *L. nevadae* have similar appearing Eurasian species with very similar genitalia; they are *L. suasa* and *L. thalassina*, respectively. The occurrence of "siblings" of so many species of *Lacanobia* (see also *L. subjuncta*) indicates a more recent invasion of the Nearctic by this genus than in *Polia*. This agrees with what has been discussed concerning possible ancestral states in *Polia*.

Lacanobia radix is easily separated from other Nearctic species in this genus by its uniformly lead-gray forewings. Specimens examined were taken May 23 to August 18.

Specimens examined: 82. ALBERTA; Calgary, July 16–23 [USNM]; Calgary, June 1–7 & June 8–15 [USNM]; Sunnydale, May 29, 1943 & June 7, 23, 1942 O. Bruggemann [AMNH]. BRITISH COLUMBIA: Kaslo [USNM]; Kaslo, June 14 [AMNH]; Duncans, May 23, 1910 [USNM]; Robson, May 28, 1936 H. R. Foxlee [JGF]. MANITOBA: Cartwright [AMNH]; Miniota, June 7, 9 & July 8 O. Buchholz [AMNH]; Riding Mts., June 11–29, 1936 J. P. May [JGF]. NEW BRUNSWICK: Dorchester, June 25, 1952 D. C. Ferguson [USNM]. ONTARIO: Charlton, June 20 O. Buchholz [AMNH]; Geraldton, July 15, 16, & 19, 1955 A. B. Klots & F. & P. Rindge [AMNH]; Geraldton, June 9, 30 & July 26, 1956 J. C. E. Riotte [AMNH]; Hymers, O. Buchholz [AMNH], July 24–31 & June 24–30 [USNM]; Nakina, June 28, 1960 J. C. E. Riotte [AMNH]; Toronto, June 12 O. Buchholz [AMNH]. QUEBEC: Mare du Sault, Montmorency Co., 2,550′, July 13, 1954 A. B. Klots & F. & P. Rindge [AMNH]. SASKATCHEWAN: Rivercourse, August 18, 1941 [AMNH]. CALIFORNIA: Sierra Nevada [AMNH]. IDAHO: Wallace, May 29, 1940 P. Huellemann [AMNH]. MAINE: Eustis, July 8 O. Buchholz [AMNH]; Lincoln, July 13 O. Buchholz [AMNH]; Moose River, July 6 O. Buchholz [AMNH]; St. Francis, July 15 O. Buchholz [AMNH]. NEVADA: Angel Creek, 7,000′, E. Humboldt Mts., SSW. of Wells, Elko Co., July 25, 1971 D. C. Ferguson [USNM]; Thompson Canyon Camp, 9 mi. SSE. Lamoile, 7,500′, July 4, 1966 F. & P. Rindge [AMNH]. NEW HAMPSHIRE: Jefferson, July 2, 1953 D. C. Ferguson [USNM]; Jefferson Notch Rd., 3,000′, July 1, 1953 D. C. Ferguson [USNM]. NEW YORK: 6 mi. E. Indian L., 43°45′30″-74°10′14″; Hamilton Co., June 13, 1977 T. L. McCabe [NYSM]. NORTH DAKOTA: Turtle Mts., Bottineau Co., June 17, 1973 T. L. McCabe [NDSU]. OREGON: Spring Creek nr. Baker, June 11, 1955 J. H. Baker [AMNH]; Gronnel Rd., 2 mi. E. Elsie, Clatsop Co., June 3, 17, 1967 & June 20, 1963, June 25, 1966, June 17, 1967 S. G. Jewett [AMNH]; Lava Lake, 3,400′, Linn Co., July 12, 1976 T. L. McCabe [TLM]. SOUTH DAKOTA: Upper Springs nr. Hill City, Black Hills, June 30, 1964 D. C. Ferguson [USNM]; Hill City, Pennington Co., July 9, 1964 D. C. Ferguson [USNM]. UTAH: Reeder Canyon, 7,000′, nr. Jose Vly. Res., Monti La Sal Nat. Frst., Emery Co., July 11, 1971 D. C. Ferguson [USNM]; Dalton Springs Camp, 5 mi. W. Monticello, 8,500′, San Juan Co., July 16, 1963 F. & P. Rindge [AMNH]. VERMONT: N. Notch Mt., Essex Co., June 18, 1975 T. L. McCabe [TLM]. WYOMING: Reuter Canyon Camp, 5 mi. N. Sundance, Crook Co., 6,100′, July 14, 1959 F. & P. Rindge [AMNH].

Trichordestra, new genus

(Figs. 2, 54, 107, 155)

Type-species: *Apamea legitima* Grote, 1864. Proc. Ent. Soc. Philadelphia 3:82, pl. 2.

Head clothed with simple scales on lower front, bidentate scales on upper front and multidentate scales on vertex; tongue well developed; labial palpi upcurved to lower fourth of front, segments one and two loosely scaled below, three closely scaled, segment two slightly longer than one and three times as long as segment three, three acute at apex; antennae simple, segments unisetose on each side; scape as wide as long, bulbous; epiphysis five-twelfths the length of fore tibia; tarsi with three rows of spinules; abdomen with a weak basal tuft.

Forewing average length to width ratio 2:1; margin weakly crenulate; 12 veins reaching margin; 3rd anal vein present at base; accessory cell present; $R_3\&_4$ stalked for a fourth distance to apex; M_3 midway between M_2 and Cu_1; M_1 from middle of accessory cell. Hindwing average length to width ratio 1.4:1; margin entire; 9 veins present; M_2 weak, located a third the distance from M_3 to M_1; R and M_1 and M_3 and Cu_1 not stalked; Cu_2 arises from three-fourths the length of cell.

Male genitalia: valve with costal process of cucullus; cucullus sickle-shaped; digitus present; right clavus larger than left; fixed penicular hairs present; vesica with a long band of spine-like cornuti.

Female genitalia: three bandlike signa; appendix arising from point of juncture of bursa and ductus bursae; appendix a tight, one-loop coil; ductus seminalis arising from apex of appendix.

Trichordestra differs from *Lacanobia* in the following characters: in the female genitalia, *Trichordestra* possesses three bandlike signa, that of *Lacanobia* has four. The apex of the appendix in *Trichordestra* is directed downward, that of *Lacanobia* is directed upward. In the male genitalia, *Trichordestra* has an upward directed cucullus, *Lacanobia* has a round or downward directed cucullus; *Trichordestra* lacks a projection of the sacculus; *Lacanobia* has an outward directed projection. The vesica of *Trichordestra* lacks a bulbed, basal cornutus and has a long band of distal cornuti; *Lacanobia* possesses a basal cornutus and has a short band of distal, raised cornuti.

Trichordestra larvae have two mandibular ridges (Godfrey, 1972)(also see *T. tacoma*). The larvae of *Lacanobia* have the second mandibular ridge enlarged or leaflike; those of *Trichordestra* do not have an enlarged second mandibular ridge (Godfrey, 1972). The larvae of *Trichordestra* show a preference for grasses; those of *Lacanobia*, for low plants other than grasses, and trees.

Trichordestra is probably a recent offshoot of a *Lacanobia*-like ancestor and is best defined by its three bandlike signa. The two opposing bands are rarely connected anteriorly. The three-signa condition appears to have resulted from the loss of one signum from a four signa ancestral state. This is evident because the signa are spaced as if a fourth signum was present, not equidistant as might be expected.

The genus is divisible into two species groups: the *legitima* group lack coremata, have a narrow cucullus and long, spine-like cornuti on the vesica; the *lilacina* group have coremata, a broad cucullus, and comparatively short spine-like cornuti. As a whole, the species in this genus are all very close and presence or absence of coremata is of great value for positive identification of the undissected adults. If the hairs of the coremata are not visible from a lateral view, the abdomen can be "snapped off" at the base and then the base of the coremata can be seen from an "end on" (anterior) view.

The genus occurs throughout Temperate North America and south at least to the middle of Mexico. Species of this genus may occur in Middle and South America, but are placed in other genera.

KEY TO THE SPECIES OF *TRICHORDESTRA* BASED UPON ADULT MACULATION

1. Forewing with well-defined W-mark extending to terminal line; claviform extending nearly to postmedial line; costal margin lighter than ground, especially in basal half; Arizona, New Mexico, Texas, and south into Mexico .... *prodeniformis*

— Forewing with W-mark, when present, not extending to terminal line; claviform rarely extending half-way to postmedial line; costal margin same color as ground; generally distributed 2

2. Small species (average wing expanse 30 mm); W-mark absent; usually with several separate, blunt, black wedges inside subterminal line; thin basal dash present .... *rugosa*

— Average size (wing expanse 35 mm or more); W-mark usually present, although often weak; wedges usually absent, but if present, then not black, but smokey colored and usually connected 3

3. Ordinary spots and lines present, but barely distinguishable from ground; rusty or reddish scaling along subterminal line, outside reniform, and at base; claviform very finely edged with black; postmedial band not distinguishable from ground; 35–39 mm .... *beanii*

— Ordinary spots and lines usually contrasting, but if inconspicuous, then no reddish scaling; claviform usually filled with black; postmedial band lighter than ground 4

4. Orbicular light throughout; male coremata absent; postmedial band blue-gray; forewing with a rust tinge in area of reniform; cubital vein (below reniform) not usually marked with white; claviform a small, black wedge, smaller than orbicular and about as long as high 5

— Orbicular brown, circumscribed by white, rarely light throughout; forewing brown or ash-gray; male coremata present or absent; cubital vein frequently white; claviform variable, frequently larger than orbicular and frequently longer than high 6

5. Claviform acute at apex; black scales below reniform, when present, tangent to reniform and not extending to Cu_2 .... *legitima*

— Apex of claviform rounded; black below reniform usually extending to Cu_2 and filling most of the angle between fork of Cu_2 and post median band .... *tacoma*

6. W-mark absent; claviform not solidly filled with black; male coremata present .... *lilacina*

— W-mark present, though sometimes weakly developed; claviform usually solidly filled with black; male coremata present or absent 7

7. Male coremata absent; space directly beneath reniform red-brown (when specimens fresh) or only a small amount of black tangent to reniform, not extending to Cu_2 (this space usually lighter than claviform) ... *dodii*

— Male coremata present; space directly beneath reniform as dark as claviform (as claviform becomes lighter, this space becomes correspondingly lighter); dark beneath reniform extending to vein Cu_2; W-mark usually well developed .... *liquida*

KEY TO THE SPECIES OF *TRICHORDESTRA* BASED UPON THE MALE GENITALIA

1. The cornuti in the form of a band about 4–6 cornuti in width 2

— Cornuti broad based and in a single row (visible as such even if vesica uneverted) .... *prodeniformis*

2. Coremata present and well developed; digitus variable, sometimes very short (as long as width at base or less); cucullus narrow, approximately a "quarter circle" (figs, 59, 60, 62) except when digitus short 3

— Coremata absent; digitus long (longer than width at base); cucullus broad, a "half circle" or more (figs. 56, 65, 66, 68) 4

3. Clavus of right valve with a secondary rounded hump .... *lilacina*

— Clavus of right valve higher than left valve, but otherwise of the same relative proportions .... *liquida*

4. Digitus very short (no longer than width at base) or vestigial 5

— Digitus longer than width at base and well developed, usually extending to or above "anal loop" (excavation of outer margin of valve below cucullus, fig. 59, al) 6

5. Cucullus a half circle (fig. 56) .... *tacoma*

— Cucullus a quarter circle (fig. 54), digitus an almost indistinguishable pimple .... *rugosa*

6. Right clavus with an acute small lobe on upper left margin .... *beanii*

— Right clavus broadly and evenly rounded 7

7. Juxta smooth; area circumscribed by the "anal loop" (fig. 59) smaller than area occupied by costal process of cucullus .... *dodii*

— Juxta with stout spines toward apex; area circumscribed by the "anal loop" greater than area occupied by costal process of cucullus .... *legitima*

KEY TO THE SPECIES OF *TRICHORDESTRA* BASED UPON THE FEMALE GENITALIA

1. Appendix arising from ductus bursae almost one-third the distance of bursa to the ostium (i.e., posterior portion of bursa constricted and cylindrical) .... *beanii*

— Appendix arising at juncture between ductus bursae and bursa 2

2. Appendix beyond point of origin free from contact with bursa 3

— Appendix contacting bursa at some point along length or at apex of appendix 4

3. Posterior edge of "stalk" of appendix flat and even; final coil of appendix about 180° . . . . *liquida*
— Posterior edge of "stalk" of appendix with a distinct notch about one-third the way out; final coil of appendix nearly 360° . . . . *prodeniformis*
4. Apex of appendix bursae distad of bursa (figs. 107, 112) 5
— Apex of appendix bursae proximad to bursa (figs. 109, 110) 7
5. Appendix nearly the same size (circumference) as bursa 6
— Appendix only about one-third the circumference of bursa . . . . *lilacina*
6. Appendix extending as far cephalad as bursa; appendix cylindrical and narrower at base . . . . *rugosa*
— Appendix extending only two-thirds as far cephalad as bursa; appendix very broad, not tubelike, at base . . . . *tacoma*
7. Bandlike signa well developed, smooth and even, rarely with one band broken or narrowed . . . . *legitima*
— Bandlike signa weakly developed, short, of varying widths and usually broken . . . . *dodii*

Trichordestra rugosa Morrison, new combination

(Figs. 54, 55, 107, 155 and Map 7)

Mamestra rugosa Morrison, 1875. Proc. Boston Soc. Nat. Hist., 18:119. Smith, 1893. Bull. U.S. Natl. Mus., 44:123. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Agric. Exp. Sta. Mem., 329:85. Type locality: Maine [MSU].

Polia rugosa, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:188, pl. 83, fig. 27. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front with light brown transverse band composed of simple and bidentate scales; palpi upcurved to middle of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with anterior crest absent, posterior crest present and divided; tegula clothed with bidentate scales and considerable hair; abdomen without tufts; coremata absent; forewing ground reddish-brown; basal dash present; W-mark very weak or absent; reniform with uniform brown annulus.

Male genitalia: (Figs. 54, 55) T.L.M. slide no. 17.

Female genitalia: (Fig. 107) T.L.M. slide no. 96.

Alar expanse: 29–34 mm.

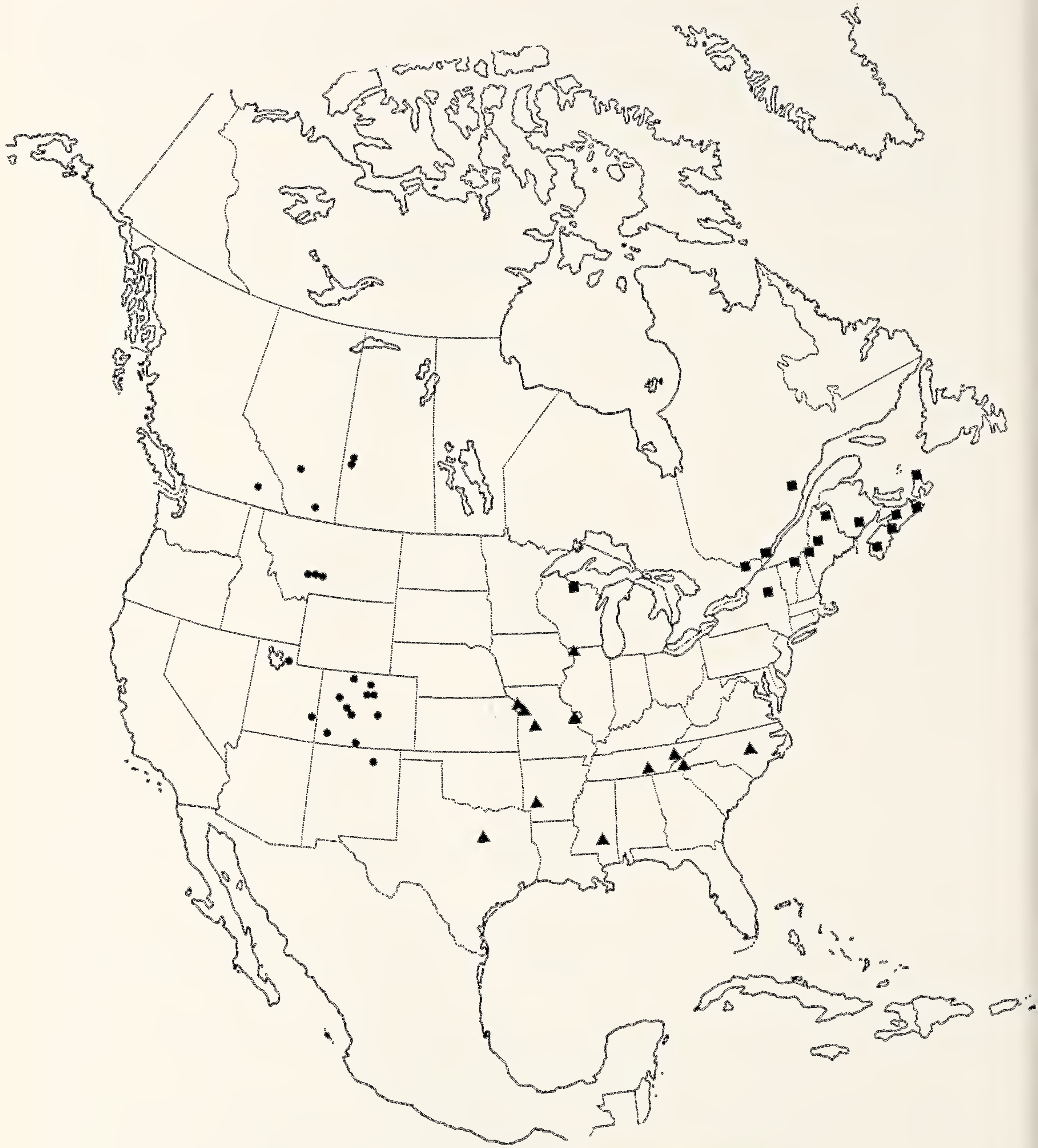
Food plant: *Pyrus melanocarpa* (Godfrey, 1972).

LECTOTYPE: present designation. A single ♂ specimen, descended from the Tepper collection now in the Michigan State University Collection and bears the following label: "Maine." [MSU].

This species belongs to the section of the genus with a narrow cucullus and lacking coremata. *T. rugosa* and *T. tacoma* are the only *Trichordestra* lacking coremata and which have the ductus seminalis arising distad of the ductus bursae; the appendix curls around so that its apex is removed from the ductus bursae. Differences from *T. tacoma* are given in the keys. *T. rugosa* has the most restricted distribution of any *Trichordestra*. Females are very rare in collections.

Specimens examined were taken May 26 to July 19.

Specimens examined: 69. QUEBEC: L. Jacques Cartier, Montgomery Co., Laurentides Pk., July 12, 1954 Klots & Rindge [AMNH]. NEW BRUNSWICK: St. J., June 21, 1900 [USNM]. NOVA SCOTIA: Debert, Colchester Co., July 19, 1961 D. C. Ferguson [USNM]; New Harbour, Guysborough Co., July 12, 13, 1956 D. C. Ferguson [USNM]; West Dover, Halifax Co., June 3, 1954, June 30, 1968 & July 15, 1968 D. C. Ferguson [USNM]; Peggy's Cove, Halifax Co., July 7, 1961 & July 11, 1953 D. C. Ferguson [USNM]; Halifax Co., July 2, 1951 [AMNH]; Lake Kejimujik, Queens Co., June 20, 1960 D. C. Ferguson [USNM]; Bog E. of Big Indian, Halifax Watershed, May 26, 1968, June 12 through 27, 1963, June 8, 1959, June 24, July 10, 1968 D. C. Ferguson [USNM]; French Mts., 1,390′, C. B. Highlands Nat. Park, June 18, 1953 D. C. Ferguson [USNM]; Mt. Uniacke, July 18, 1946 D. C. Ferguson [USNM]. ONTARIO: Mer Bleue, June 16, 1908 [USNM]. MAINE: Ashland, July 1 [AMNH]; Greenville, July 8 [AMNH]; Oguossoc, June 30, July 4 [AMNH]; 4 mi. S. Wilson Mills, Oxford Co., July 8 [AMNH]. NEW YORK: S. Inlet, Raquette L., 1,780′, Hamilton Co., 43°48′16″-74°36′30″, July 16, 1977 T. L. McCabe [NYSM]. VERMONT: N. Notch Mt., Essex Co., June 18, 1975 T. L. McCabe [TLM]. WISCONSIN: Lake Katherine, Oneida Co., July 3, 1948 H. M. Bower [AMNH]; Lake Katherine nr. Hazelhurst, Oneida Co., June 25, 1963 H. M. Bower [LACM].



Map 7.—Geographical distribution of members of *Trichordestra*.

■ *T. rugosa* Morrison ▲ *T. beanii* Grote ● *T. dodii* Smith

Trichordestra tacoma Strecker, new combination

(Figs. 56, 57, 108, 156)

Mamestra tacoma Strecker, 1900. Lepidoptera, Rhopaloceres and Heteroceres, Indigenous and Exotic, supplement 3, p. 31. Dyar, [1903] 1902. Bull. U.S. Natl. Mus., 52:156. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:84.

Type locality: Seattle, Washington [FMNH-Chicago].

Polia tacoma, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:137, pl. 81, fig. 28. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front with transverse reddish band of bidentate scales on middle; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with anterior crest absent, posterior crest present and divided; tegula clothed with tridentate scales and considerable hair; abdomen without tufts; coremata absent; forewing with ground blue-gray with reddish basally; claviform a blunt wedge; reniform only rarely appearing darker in lower half.

Male genitalia: (Figs. 56, 57) T.L.M. slide no. 198.

Female genitalia: (Fig. 108) T.L.M. slide no. 18.

Alar expanse: 28–37 mm.

Food plant: low plants, willow, *Epilobium* and chokecherry (Godfrey, 1972). *Sambucus canadensis* L., *Vaccinium myrtilloides* Michx., *Prunus virginiana* L., *Spiraea latifolia* Ait., *Betula papyrifera* Marsh., *Apocynum androsaemifolium* L. (all records given as new are for those plants accepted by the first instars) [TLM].

All known species of *Trichordestra* have larvae with two mandibular ridges. The presence of only one mandibular ridge in *T. tacoma*, coupled with an unstriped habitus, caused Godfrey (1972) to group it with *L. subjuncta* and *Mamestra sensu stricto*, a position which is untenable. Since Godfrey's revision, I have reared *T. tacoma* from ova from a determined female and discovered the larvae have two mandibular ridges, very similar to *T. rugosa* with which the adults are very close genitalically. The mandibular teeth are more shallow than those of *T. rugosa*. In addition, some larvae have a red phase which is distinctly striped, reminiscent of the typical *Trichordestra* larva. Godfrey was only able to examine larvae determined by association with this species. He illustrated a noctuid species other than *T. tacoma*, possibly a species of *Papestra*.

Specimens examined: 370 from the following provinces and states: Alberta, British Columbia, Manitoba, Nova Scotia, Ontario, Quebec, California, Colorado, Idaho, Maine, Massachusetts, Minnesota, Montana, New Hampshire, New York, North Dakota, Vermont, Washington, and Wisconsin. The species occurs in the Transitional and Canadian life zones.

Trichordestra legitima Grote, new combination

(Figs. 2, 58, 59, 109, 157)

Apamea legitima Grote, 1864. Proc. Ent. Soc. Philadelphia, 3:82, pl. 2.

Type locality: "Middle and eastern states" [not determined, type represented by an engraving on plate 2 accompanying the original description. Smith (1893, p. 123) commented on the type: "The type should be, but is not, in the collection of the Amer. Ent. Soc."

Mamestra legitima, Smith, 1893. Bull. U.S. Natl. Mus., 44:123. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Agric. Exp. Sta. Mem., 329:84.

Polia legitima, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:149, pl. 82, fig. 11. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front clothed with simple or bidentate scales, transverse band absent; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with anterior crest absent, posterior crest present and divided; tegula clothed with 4- and 5-dentate scales with occasional black-tipped scales; abdomen without tufts; coremata absent; forewing ground blue-gray with reddish cast in median area; wings with ordinary lines and spots present; claviform a black wedge; reniform dark in lower half; W-mark present, weak.

Male genitalia: (Figs. 58, 59) T.L.M. slide no. 98.

Female genitalia: (Fig. 109) T.L.M. slide no. 272.

Alar expanse: 25–35 mm.

Food plant: Asparagus, seeds of *Asclepias incarnata*, *Agrostis hyemalis*, blackberry, cabbage, clover, collards, *Muhlenbergia gracillima*, pea, rape, rutabaga, *Salix humilis*, *Solidago*, *Syntherisma sanguinale* (sic), tobacco, turnip, violet, willow, grass heads (Godfrey, 1972). *Asclepias* sp. (John Rawlins, pers. comm.). *Apocynum androsaemifolium* L., *Salix bebbiana* Sarg., *Aster umbellatus* Mill., and *Achillea millefolium* L. [TLM].

T. legitima is the only species in the genus with short, thick, broad-based spines on the juxta (fig. 124). The females are similar to *T. dodii*, but the bandlike signa rarely appear broken. In adult maculation, *T. legitima* has a plain, light orbicular; that of *T. dodii* is brown filled.

Specimens examined were taken June 1 to September 4. The species is distributed from Canada south to California and Texas in the West and Florida in the East.

Specimens examined: 520 from the following provinces and states: Manitoba, Nova Scotia, Ontario, Quebec, Arkansas, California, Florida, Maine, Massachusetts, Michigan, Minnesota, Montana, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Vermont, and Wisconsin.

Trichordestra dodii Smith, new combination

(Figs. 60, 61, 110, 158 and Map 7)

Mamestra dodii Smith, 1904. Can. Ent., 36:152.

Type locality: "Mouth of Fish Creek"; "Calgary, Alta." [USNM].

Polia dodi, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:150, pl. 82, fig. 12. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front with weak transverse band of simple scales; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax without crests; tegula clothed with mostly simple and bidentate scales; abdomen without tufts; coremata absent; forewing ground reddish-brown; wings with ordinary spots and lines present; claviform prominent; reniform dark in lower half; W-mark present, though often weak.

Male genitalia: (Figs. 60, 61) T.L.M. slide no. 127.

Female genitalia: (Fig. 110) T.L.M. slide no. 240.

Alar expanse: 30–35 mm.

Food plant: unknown.

Trichordestra dodii is easily mistaken for *T. liquida* or *T. legitima* (see discussion under *T. legitima*). *Trichordestra dodii* possess coremata whereas *T. liquida* lack coremata. Specimens examined were taken June 18 to July 31.

Specimens examined: 231. ALBERTA: a large series has been taken by F. H. Wolley Dod and these are deposited in the USNM, AMNH, CNC, & LACM. All are from Calgary over a 40-year span. Dates range from June 18 to July 31. Other Alberta localities follow: Sunnydale, July 5, 8, 1942 P. F. Bruggemann [AMNH]; Lethbridge, July 1, 1929 H. L. Seamans [CNC]; Elkwater, June 20, 1956 E. E. Stearns [CNC]. BRITISH COLUMBIA: Kaslo [USNM]; Ft. Calgary, June 25 [USNM]. SASKATCHEWAN: Attons Lake, Cut Knife, June 23, 1940 A. R. Brooks [CNC]; Harlan, June 4, 1942 P. F. Bruggemann [AMNH]; Rutland, June 27, 1940 A. R. Brooks [CNC]. COLORADO: Trujillo Meadow Cmp., 3 mi. N. Combres, Conejos Co., 10,000′, July 15, 1922 [USNM]; Gothic, Gunnison Co., 9,500′, July 3 to July 13, 1961 O. R. Taylor [AMNH]; Gothic, 9,700′, June 28 and July 6, 1963 T. C. Emmel [LACM]; Gothic, 9,500′, July 3 to 27, 1965 C. L. Remington [JGF]; Gothic, July 2, 20, 1949 W. J. Reinthal [CNC]; 3 mi. N. Gothic, Gunnison Co., July 14, 1970 P. E. Breedlove [CAS]; Hermosa, La Plata Co., July 8, 1959 C. L. Hogue [LACM]; Aspen, Pitkin Co., July 8, 1965 P. Feinsinger [DAVIS]; Maroon Bells, Aspen, Pitkin Co., July 8, 1976 C. P. Bagdonas [CPB]; 3 mi. N. Rabbit Ears Pass, Routt Co., 10,000′, July 15, 1956 F. Rindge [AMNH]; Florrisant, Teller Co., 8,640′, June 22, 1962, July 8, 25, 1962, July 14, 1960 T. C. Emmel [LACM]; Glenwood Springs, July 8–15 F. H. Wolley Dod [USNM]; Longs Peak Inn, June 30, 1920 E. C. Van Dyke [CAS];

Rollins Pass Rd., June 28, 1976 C. P. Bagdonas [CPB]; Rocky Mt. Nat. Pk., July 24, 1933 J. Sperry [AMNH]; Bullion Peak, July 27 [AMNH]. MONTANA: Yellowstone River, 3,860′, 3.4 mi. SE. Greycliff, Sweet Grass Co., October 30, 1967 (reared) G. Godfrey [JGF]; Bozeman, June 20, 1926 [MINN]; Gallatin Co., June 30, 1917 [MINN]. NEW MEXICO: Panchuca R. S. nr. Cowles, July 6–9, 1957 A. B. Klots [AMNH]. UTAH: Brighton, July 16, 1930 [LACM]; La Sal Mts., 9,000′, July 10–20, 1933 G. G. Richards [MINN].

Trichordestra beanii Grote, new combination

(Figs. 62, 63, 111, 159 and Map 7)

Mamestra beanii Grote, 1877. Can. Ent., 9:87. Smith, 1893. Bull. U.S. Natl. Mus., 44:123. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:84–5.
Type locality: Galena, Illinois [BM(NH)].
Polia beani, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:148, pl. 82, fig. 10. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front clothed with white-tipped simple and bidentate scales, no transverse band; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax without crests; tegula with 4- and 5-dentate scales; abdomen without tufts; coremata absent; forewing ground gray with a reddish tinge outside reniform, along subterminal line, and at base; wings with ordinary lines and spots present, blending with ground; reniform dark in lower half; W-mark present.

Male genitalia: (Figs. 62, 63) T.L.M. slide no. 146.

Female genitalia: (Fig. 111) T.L.M. slide no. 126.

Alar expanse: 37–42 mm.

Food plant: unknown.

T. beanii is the least common species in collections in the genus. Specimens examined were taken August 7 to September 15.

Specimens examined: 11. ARKANSAS: Hope, August 9, 1931 L. Knobel [CNC]. ILLINOIS: Galena [BM]. MISSISSIPPI: Camp Shelby nr. Hattiesburg, September 15, 1944 C. D. Michener [AMNH]. MISSOURI: Independence, Jackson Co., August 21, 1968 J. Heitzman [AMNH]; Kansas City, August 14 F. J. Hall [AMNH]; St. Louis, August 7, 1904 H. McElhose [USNM]; 4 mi. NW. Warsaw, Benton Co., August 24, 1967 J. Heitzman [AMNH]. NORTH CAROLINA: Southern Pines, September 2, 1912 A. H. Manee [CNC]; Highlands, August 17, 1957 C. J. Durden [CNC]. TENNESSEE: Monteagle, August 31, 1929 Richards [USNM]; Knoxville, August 10, 1934 [CNC]. TEXAS: Laguna Park, Bosque Co., September 24, 1970 A. Blanchard (specimen not seen) [in collection of A. Blanchard].

Trichordestra lilacina Harvey, new combination

(Figs. 64, 65, 112, 160, 161)

Mamestra lilacina Harvey, 1874. Bull. Buffalo Soc. Nat. Sci., 2:119. Smith, 1893. Bull. U.S. Natl. Mus., 44:123. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:84.
Type locality: Brewsters, New York [BM(NH)].
Mamestra illebefacta Morrison, 1874. Proc. Boston Soc. Nat. Hist., 17:141.
Type locality: Beverly, Massachusetts [not determined].
Polia (*Mamestra*) *luski* Barnes & McDunnough, 1913. Contri. Nat. Hist. Lep. N. A., 2:106, pl. 7, fig. 8.
Type locality: White Mts., Arizona [USNM].
Polia lilacina, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:150, pl. 82, fig. 13. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front clothed with bidentate scales, no transverse band; palpi upcurved to lower front; male antennae simple, segments unisetose on each side; female antennae similar but with shorter setae; thorax with anterior crest absent, posterior crest present and divided; tegula clothed with 3- and 4-dentate scales and hair; coremata present; forewing with ground gray-brown; claviform a black wedge or an outline of a wedge (in form "*illebefacta*"); reniform dark in lower half; W-mark weak or absent.

Male genitalia: (Figs. 64, 65) T.L.M. slide no. 81 & 162.
Female genitalia: (Fig. 112) T.L.M. slide no. 244.
Alar expanse: 28–36 mm.
Food plant: Aster, asparagus, seed heads of timothy and redtop (Godfrey, 1972).

The form "*illebefacta*" occurs in all populations, but the differences between it and typical *T. liliacina* are less striking in southwestern populations (subspecies *luski*). Form "*illebefacta*" appears to be dominant in many parts of the species range; e.g., all Oregon *T. lilacina* examined were form "*illebefacta*." *T. lilacina* can be separated from other species in the genus by the presence of coremata and absence of a W-mark.

Specimens examined were taken June 4 to August 28. The species is distributed from Canada south to Arizona and New York.

Specimens examined: 390 from the following provinces and states: Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, Quebec, Saskatchewan, Arizona, California, Colorado, Idaho, Minnesota, Montana, Nevada, New Hampshire, New Mexico, New York, North Dakota, Oregon, South Dakota, Utah, and Washington. The species is more common in the West and occurs in the Transitional and Canadian life zones.

Trichordestra liquida Grote, new combination

(Figs. 66, 67, 113, 162, 163 and Map 8)

Mamestra liquida Grote, 1881. Papilio, 1:58. Smith, 1893. Bull. U.S. Natl. Mus., 44:116.
Type locality: "Washington Territory" [BM(NH)].
Mamestra meodana Smith, 1910. Jour. New York Ent. Soc., 18:95. NEW SYNONYMY.
Type locality: Calgary, Alberta; Arrowhead Lake, B.C.; Pullman, Washington; Yellowstone Park, Wyoming; Denver, Colorado [Rutgers].
Polia liquida, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:132, pl. 81, fig. 24. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.
Polia meodana, McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front covered with 2–4 dentate scales and a light-brown transverse band; palpi upcurved to lower front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with anterior crest absent, posterior crest present and divided; tegula clothed with 3–4 dentate scales, usually with a row of bluntly 5-dentate scales; abdominal tufts absent; coremati present; forewing ground silvery-gray to brownish-gray; reniform darker in lower half; claviform a black wedge, occasionally elongate; W-mark present and prominent.

Male genitalia: (Figs. 66, 67) T.L.M slide no. 110 & 139.
Female genitalia: (Fig. 113) T.L.M. slide no. 111.
Alar expanse: 35–40 mm.
Food plant: Grasses and aster (Godfrey, 1972).
Type: Rutgers.
Type locality: Calgary, Alberta; Arrowhead Lake, B. C.; Pullman, Washington; Yellowstone Park, Wyoming; Denver, Colorado.

The maculation of *T. liquida* is variable; it averages larger and lighter with more distinct markings (esp. W-mark) along the coast in the Northwest. The species becomes duller in appearance southward and inland (*meodana* Smith), though in the Black Hills, South Dakota, it again appears lighter and more contrasty. I found no genitalic differences between *liquida* and *meodana* and as the forewing pattern is subject to considerable variation, Smith's *meodana* is treated as a synonym.

Trichordestra liquida males can be readily separated from *T. dodii* males by the presence of coremata. Specimens examined were taken May 3 to July 26.

Specimens examined: 151. ALBERTA: Banff [USNM]; Calgary, June 22, 1909; June 2–16, 1914 F. H. Wolley Dod [CNC]; Calgary, July 9, 1909 [USNM]; Calgary, June 24 [AMNH]; Elkwater Lake, June 10, 1956 E. E. Stearns [CNC]; Pendor Harbor, June 9, 1928 G. R. Hopping [CNC]. BRITISH COLUMBIA: Arrowhead Lake, June 8–15 [AMNH & USNM]; Duncan, Vancouver Island, May 15 through June 12 (one marked September 16, 1913 may have been reared) [USNM]; Jesmond, July 23, 1939 J. K. Jacob [CNC]; Quamichan, Vancouver Island, June 4, 1900 [CNC]; Quesnel, June 6, 1930 [AMNH]; Robson, June 12, 1950 H. R. Foxlee [CNC]; 6 mi. W.

Terrace, June 8, 1960 B. Heming [CNC]; Wellington, May 30 and June 11, 1958, June 4 & 5, 1955 R. Guppy [USNM]; Wellington, June 1, 1903 G. W. Taylor [USNM]; Ucluelet, June 7 & 19, 1909 C. H. Young [CNC]; Victoria, May 12, 1910 & May 28, 1902 [USNM]; Victoria, June 7, 1917 E. Balkemore [CNC]. CALIFORNIA: Davis Creek, Modoc Co., June 16–24, 1922 A. W. Lindsey [USNM]; Sagehen Creek, Nevada Co., July 6, 1962 R. L. Westcott [LACM]. COLORADO: Aspen, Maroon Bells, 10,500′, Pitkin Co., July 8, 1976 C. P. Bagdonas [TLM]. MONTANA: Half Moon Park, Crazy Mts., 6,500′, Sweet Grass Co., June 26 & July 11, 1969 J. G. Franclemont [JGF]; Big Timber Creek, 6,500′, Half Moon Pk., Crazy Mts., Sweet Grass Co., June 26, 27 & July 6, 1966 D. C. Ferguson [USNM]; Little Timber Crk., 5,743′, Crazy Mts., Sweet Grass Co., June 29, 1966 D. C. Ferguson [USNM]; Glacier Nat. Pk., August 1–7 [USNM]; Bozeman, June 30, 1923 [MINN]; Bozeman, June 9, 1928 [CNC]. IDAHO: Badger Creek, 3,500′, Idaho Co., July 4, 1976 T. L. McCabe [TLM]; Moscow, June 1, 1945 T. A. Brudley [CNC]; Wallace, June 13, 1916 to July 4, 1940 O. Huellemann [USNM, JGF, MINN, AMNH]. OREGON: 5 mi. NW. Corvallis, Benton Co., July 4, 1931 [USNM]; MacDonald Forest, 500′, Benton Co., May 3, 1961 N. MacFarland [LACM]; 4 mi. W. Oregon City, Clackamas Co., May 27 to June 15, 1972 S. G. Jewett [AMNH]; Joseph, Wallowa Co., J. Sperry [LACM]; Washington Co., July 7, 1964 Perkins [LACM]; McMinnville, Yamhill Co., May 12 & June 14, 1953 K. M. Fender [JGF]; Baker, June 11, 1955 J. Baker [AMNH]; Cartney, May 29, 1933 [USNM]; Coquille, May 13, 1939 (at bait) [USNM]; Forest Grove, May 20, 1928 [USNM]; Lebanon, May 31, 1917 M. Reeher [USNM]; Wallowa Lake, June 21, 1942 J. H. Baker [CAS]; Woodburne, June 10, 1937 [AMNH]. SOUTH DAKOTA: Upper Spring Creek nr. Hill City, Black Hills, June 30, 1964 D. C. Ferguson [USNM]; Hardy, West Camp, July 3, 1965 R. W. Hodges [USNM]. UTAH: Reeder Canyon, 7,000′, Monti La Sal Nat. Frst., Emery Co., July 11, 1971 D. C. Ferguson [USNM]; 22 mi. NNW. Vernal, Uintah Co., July 24, 1963 F. Rindge [AMNH]; Brighton, July 16, 1930 [LACM]. WASHINGTON: Bellingham, May 25, 1929 J. F. G. Clarke [JGF]; Bellingham, May 30, 1922 J. F. G. Clarke [USNM]; Olympia, June 16, 1893 [USNM]; Puyallup, June 9, 1923 J. F. G. Clarke [USNM], June 8, 10, 1928 W. W. Baker [USNM]; Seattle, July 21 [USNM] & September 21 (reared?) [USNM]; Spokane, July 26 [USNM]. WYOMING: Yellowstone Nat. Pk., 7,800′, July 9, 17, 1955 F. Hartig [AMNH].

Trichordestra prodeniformis Smith, new combination

(Figs. 68, 69, 114, 164 and Map 8)

Mamestra prodeniformis Smith, [1888] 1887. Proc. U.S. Natl. Mus., 10:464. Smith, 1893. Bull. U.S. Natl. Mus., 44:117.

Type locality: southwestern Arizona [USNM].

Polia prodeniformis, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:127, pl. 81, fig. 18. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front with weak transverse light brown band composed of simple and bidentate scales; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with anterior crest absent, posterior crest weak, divided; tegula clothed with 2- and 3-dentate scales and considerable hair; abdomen without tufts; coremata present; forewing with ground dark gray-brown; claviform extremely elongate; reniform darker in lower half; W-mark prominent.

Male genitalia: (Figs. 68, 69) T.L.M. slide no. 56.

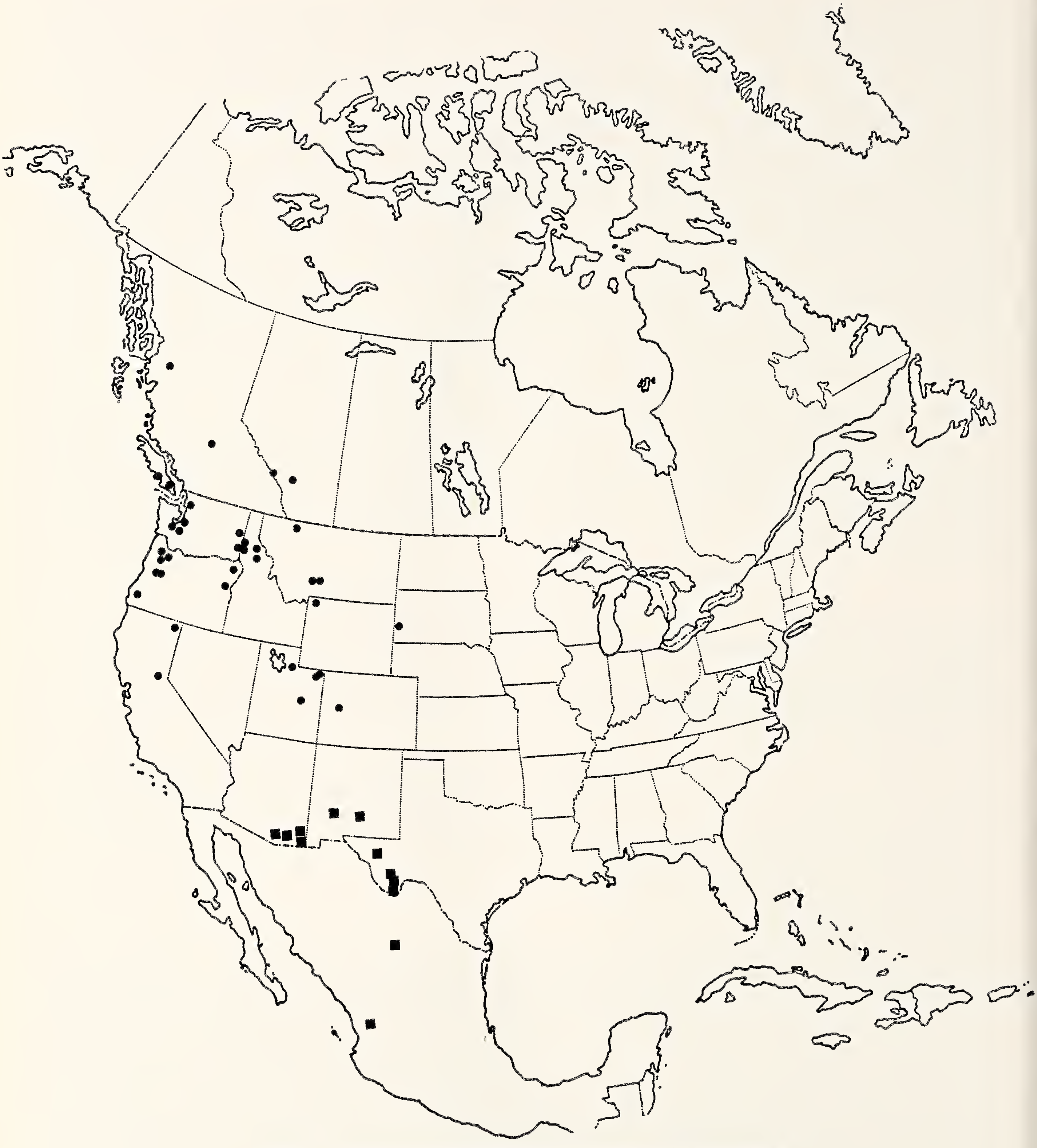
Female genitalia: (Fig. 114) T.L.M. slide no. 58.

Alar expanse: 30–35 mm.

Food plant: grasses (Godfrey, 1972).

T. prodeniformis is distinctive in having a large claviform, extending nearly to postmedian line, a prominent W-mark, reaching terminal line, and the vesica with a single row of enlarged, stout spines. It is probably more common in Mexico than our records indicate. Specimens examined were taken July 20 to October 5.

Specimens examined: 194. ARIZONA: Paradise, Cochise Co., September [USNM]; Miller Canyon, 5,000′, Huachuca Mts., Cochise Co., August 11, 12, 1974 T. L. McCabe [TLM]; Pinery Canyon, Chiracahua Mts., Cochise Co., August 24, 25, 1967 J. G. Franclemont [JGF]; Huachuca [USNM]; Sycamore Canyon, Atasco Mts., August 23, 1962 E. Fisher [LACM]; Madera Canyon, August 7, 1962 E. Fisher [LACM]; Pinery Canyon, Chiracahua Mts., August 21, 1962 E. Fisher [LACM]; Palmerlee [USNM]; Onion Saddle, 7,600′, Chiracahua Mts., Cochise Co., August 21, 22, 29, 1967 & July 20, August 8, 1966 J. G. Franclemont [JGF]; Cave Creek Canyon, 4,880′, Chiracahua Mts., Cochise Co., August 5, 23, 1967, July 31 through August 10, 1966 J. G. Franclemont [JGF]; East Turkey Creek, 6,400′, Chiracahua Mts., Coehise Co., July 30, 1967 J. G. Franclemont [JGF]; Silver



Map 8.—Geographical distribution of members of *Trichordestra.*

● *T. liquida* Grote ■ *T. prodeniformis* Smith

Creek Wash, 4,880′, 7 mi. W. Portal, Cochise Co., August 24, 1966 J. G. Franclemont [JGF]; Madera Canyon, 4,880′, Santa Rita Mts., Santa Cruz Co., July 20 to August 26, 1966 J. G. Franclemont [JGF]; Pena Blanca, 3,950′, Santa Cruz Co., August 11, 16, 1966 J. G. Franclemont [JGF]. NEW MEXICO: N.M., F. H. Snow [USNM]; Hot Springs, 7,000′, September [AMNH]; High Rolls, August 1–15 [USNM]. TEXAS: Alpine, August 8 through 31, 1926 O. C. Poling [USNM]; Brewster Co., August 1–15, 1927 [LACM]; Davis Mts., July 7, 1961 R. L. Westcott [LACM]; Sierra Diablo W. M. A., 6,400′, Culberson Co., August 29 through 31, 1970 J. G. Franclemont [JGF]; (The following Texas records were not seen but the data was sent to me by W. McGuire from material in Andre Blanchard's collection), BBNP, the Basin, Brewster Co., September 22, 24, 1963, October 5, 1967 A. Blanchard; Mt. Locke, Jeff Davis Co., August 30, 1969 A. Blanchard; Ft. Davis, Jeff Davis Co., July 29 through August 27, 1964, June 26, 1965, October 5, 1969 A. Blanchard; Sierra Diablo Mts., Hudspeth Co., September 24, 1967, September 1, 1969 A. Blanchard. MEXICO: Tacubaya, August [AMNH]; Zacualpan, August 19, September 13 [USNM].

Papestra Sukhareva

(Figs. 3, 70, 115, 165)

Papestra Sukhareva, 1973. Ent. Obozr., 52:409 by original designation. NEW STATUS.
Type-species: *Phalaena biren* Goeze, 1781. Ent. Beyträge 3(3):206.

Head clothed with simple scales on lower front, bidentate scales on upper front, and multidentate scales on vertex; tongue well developed; labial palpi upcurved to middle of front, segments one and two loosely scaled below, three closely scaled, segment two slightly longer than segment one and three times as long as segment three, three acute at apex; antennae simple, segments unisetose on each side; scape wider than long, bulbous; epiphysis five-twelfths length of fore tibia; tarsi with three rows of spinules; abdomen tufted; coremata present.

Forewing: average length to width ratio 2.2:1; margin weakly crenulate; 12 veins reach margin; 3rd anal vein present at base; accessory cell present; $R_3\&_4$ stalked for one-third distance to apex; M_3 arises midway between M_2 and Cu_1 from middle of accessory cell. Hindwing: average length to width ratio 1.5:1; margin weakly crenulate; 9 veins present; M_2 located two-fifths the distance from M_3 to M_1; R & M_1 and M_3 & Cu_1 not stalked; Cu_2 arises from three-fourths the length of cell.

Male genitalia: Valve with flat-topped cucullus; process of costa present; fixed penicular hairs present; clavus variable, often protruding; vesica extremely elongate with distal cornuti (patch of spines).

Female genitalia: Bursa vestigial; appendix a long, cylindrical tube with ductus seminalis arising from apex.

Papestra differs from *Trichordestra* in the following characters: Female bursa vestigial in *Papestra*; whereas *Trichordestra* has a well-developed bursa with three bandlike signa. The male vesica in *Papestra* has a short band of short cornuti; in *Trichordestra* a long band of cornuti is present. The cucullus in *Papestra* is a squat, flat-topped structure; that of *Trichordestra is a curving, sickle-shaped structure.*

Papestra is apparently the only genus of the Hadeninae with a vestigial bursa. The genus is probably North American in origin. As a result of an introduction, all five known species of *Papestra* occur in the Nearctic region.

KEY TO THE SPECIES OF *PAPESTRA* BASED UPON THE ADULT MACULATION*

1. Postmedial band prominent 2
— Postmedial band not, or barely, distinguishable from ground except perhaps in the fold 3
2. Postmedial line very close to outer angle of reniform, sometimes touching it and then bowing out opposite center of reniform; reniform widest in top third; black wedges of subterminal line weak inside W-mark .... *biren*
— Postmedial line usually running parallel to outer side of reniform, slightly bowed opposite center of reniform, but not converging with reniform at lower, outer angle; reniform of uniform width throughout; rarely with lower portion of reniform drawn out toward orbicular .... *quadrata*
3. Wingspan 40–50 mm; ordinary spots nearly the same shade as ground; subterminal line with the white W-mark usually broken or absent entirely; California north to British Columbia and Idaho .... *invalida*
— Wing expanse 32–40 mm; ordinary spots lighter than ground; W-mark frequently with a complete white outline 4

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* Positive identification depends on male genitalia.

4. Reniform and orbicular both the same shade; median dash frequently present, though fine; western United States and British Columbia . . . . *brenda*
— Reniform lighter than orbicular; orbicular nearly the same shade as ground; median dash rarely present; Colorado north to Washington and British Columbia, then east into Ontario . . . . *cristifera*

KEY TO THE SPECIES OF *PAPESTRA* BASED UPON THE MALE GENITALIA

1. Clavus protruding one-half the distance of its width; cucullus not set off by obvious "neck" . . . . *biren*
— Clavus protruding one-third or less the distance of its width; cucullus set off by a distinct "neck" 2
2. Clavus not protruding 3
— Clavus noticeably protruding (at least on one valve) . . . . *quadrata*
3. Clavi forming a broad "V" with one another (fig. 84) 4
— Clavi at right angles to axis of valve (fig. 83) . . . . *brenda*
4. Clavus sloping upward and then abruptly bending laterally; vesica with short, thick, "tear-drop" shaped cornuti (fig. 81) . . . . *invalida*
— Clavus sloping smoothly upward (fig. 84); vesica with fairly long, tapering cornuti (similar to *brenda*) (fig. 82) . . . . *cristifera*

KEY TO THE SPECIES OF *PAPESTRA* BASED UPON THE FEMALE GENITALIA

1. Seventh sternite triangular with well-defined notch (figs. 121–3) 2
— Seventh sternite triangular or rectangular, but without deep notch (figs. 119–120) 4
2. Tip of ovipositor to most cephalad point of appendix, in normal configuration, 8 mm in length . . . . *invalida*
— Tip of ovipositor to most cephalad point of appendix 6 mm in length 3
3. Projections of seventh sternite appear smooth in outline and are rounded in cross section . . . . *cristifera*
— Projections appear rough in outline and somewhat flattened in cross section, sometimes appearing "double" . . . . *brenda*
4. Seventh sternite triangular with shallow v-shaped notch (fig. 119) . . . . *biren*
— Seventh sternite rectangular with little or no indication of a notch (fig. 120) . . . . *quadrata*

Papestra quadrata Smith, new combination

(Figs. 70–75, 115, 120, 165–167 and Map 9)

Mamestra quadrata Smith, 1891. Proc. U.S. Natl. Mus., 14:128, pl. 11. Smith, 1893. Bull. U.S. Natl. Mus., 44:124.

Type locality: Placer Co., California [USNM].

Mamestra ingravis Smith, 1895. Ent. News, 6:337, pl. 15. NEW SYNONYMY. Dyar, 1902. Bull. U.S. Natl. Mus., 52:152. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:83–4.

Type locality: Calgary, Alberta [USNM].

Polia quadrata, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:138, pl. 81, fig. 29. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Polia ingravis, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:108, pl. 81, fig. 8. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Front with broad, brown, transverse band composed of bidentate scales; palpi upcurved nearly to middle of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with divided anterior and posterior crests; tegula clothed with 2-, 3-, 4-, and 5-dentate scales; abdomen with four or five tufts, increasing in size to the third then decreasing in size; coremata present; forewing with ground gray-brown to dark brown; ordinary lines sometimes obscured in southwestern specimens; median dash present or absent; W-mark present; reniform sometimes extending to orbicular.

Male gentialia: (Figs. 70–75) T.L.M. slide nos. 235 & 236. U.S.N.M. slide no. 1964.
Female genitalia: (Fig. 115) T.L.M. slide no. 266.
Alar expanse: 28–39 mm.

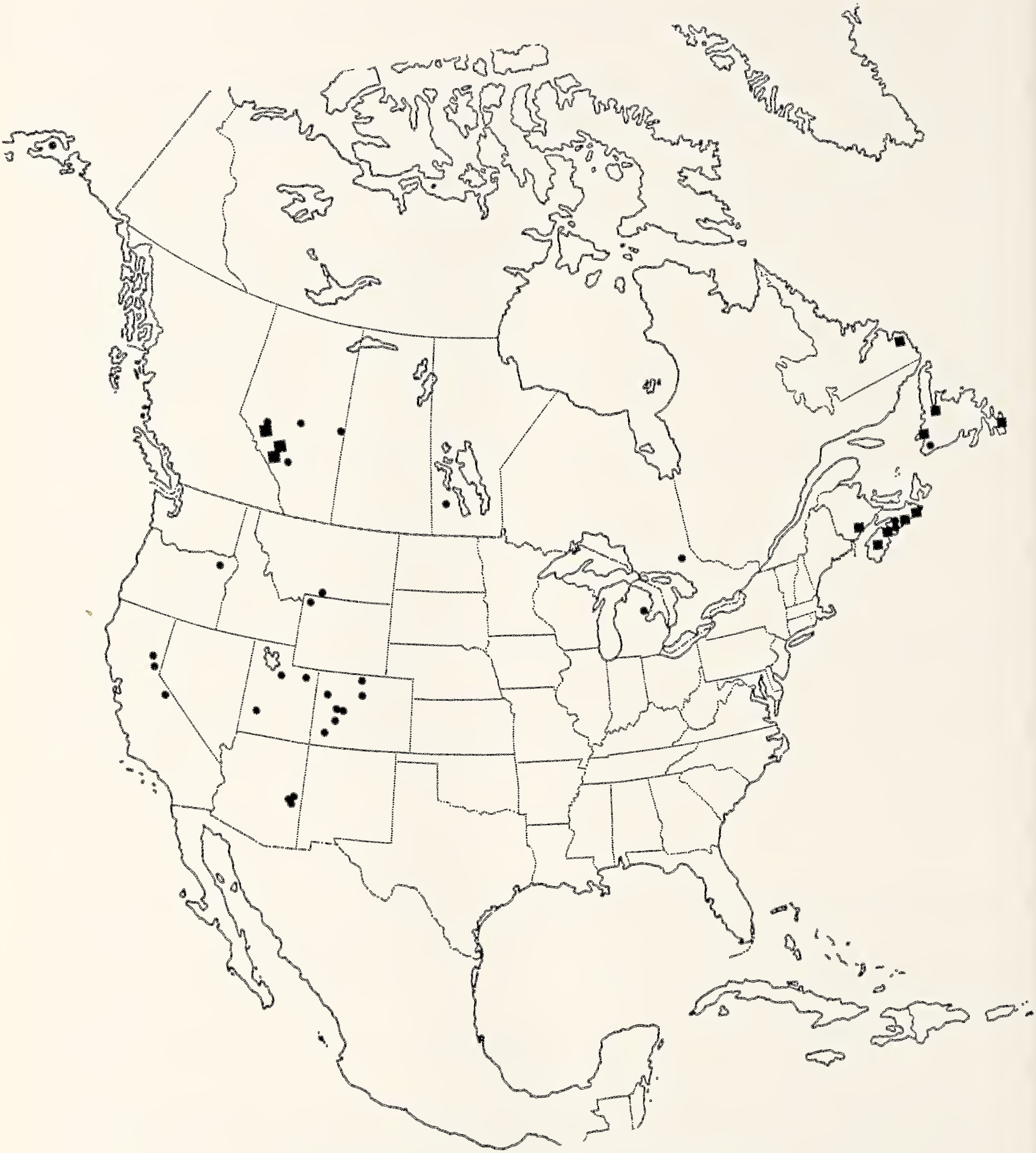
Papestra ingravis is treated as an eastern subspecies of *P. quadrata*. Both wing pattern and male genitalic characters appear distinct at ends of the clines. Topotypical *P. quadrata* have the "process of costa" (terminology of Sukhareva, 1973) directed toward the excavation below the cucullus (al, fig. 59), or upward, or both, the right valve may be different from the left valve. This is not an artifact of preparation as the structures are immovable. In specimens from British Columbia and Alberta the forewing patterns blend together producing a continuum of intermediates between *ingravis* and nominate *quadrata*.

Because there are no constant internal or external structural differences between *P. quadrata* and *P. ingravis*, and in view of the situation in Colorado and western Canada, I am treating them as eastern and western subspecies. Only the extreme phenotypes of this species have been illustrated. These appear to be good species if examined separately, but a gamut of transitional forms exist. Specimens examined were taken May 15 to August 16. Specimens examined: 173. ALBERTA: Calgary, May 20, 1894, May 22, 1896, May 31, 1902 F. H. Wolley Dod [CNC]; Calgary, June 1–7, May 24–30 [USNM]; Nordegg, June 23, 1921 J. McDunnough [USNM]; Lloydminster, May 15, 1949 P. F. Bruggemann [CNC]; Edmonton, May 15, 1922 A. G. Richards [MINN]. BRITISH COLUMBIA: Balsam Lake 6,000′, July 19, 1952 G. P. Holland [CNC]. MANITOBA: Riding Mts., June 26, 1936 J. P. May [JGF]. NEWFOUNDLAND: Doyles, Codroy Vly., June 28 through July 8, 1969 & August 5, 1962 D. C. Ferguson [USNM]; Great Village, August 4, 1945 A. D. Hall [CNC]; West Dover, Halifax Co., June 3, 1954 D. C. Ferguson [CNC]; (40) Bog E. of Big Indian L., Halifax Co., Halifax Watershed, June 12 through June 27, 1963 D. C. Ferguson [USNM]; Peggy's Cove, Mt. Uniacke, & West Dover, all collected in June by D. C. Ferguson [USNM]. ONTARIO: Sudbury [CNC]. ALASKA: 10 mi. E. Kenai Pen., May 30, 1951 W. J. Brown [CNC]. ARIZONA: White Mts., June 16, 18, 19, 1935 J. Sperry [AMNH]. CALIFORNIA: Placer Co., June [CNC]; Nelson Creek, Plumas Co., June 25, 1955 Buckett & Bauer [JGF]; Bishop (14 mi. SW) August 8, 1967 D. F. Hardwick [CNC]. COLORADO: Gothic, Gunnison Co., August 16, 1961 C. L. Remington [USNM]; Aspen, Pitkin Co., June 5, 1976 C. P. Bagdonas [CPB]; Maroon Bells, Pitkin Co., July 8, 1976 C. P. Bagdonas [CPB]; Doolittle Ranch, Mt. Evans, July 16, 1961 E. W. Rockburne [CNC]; Collegrati Peaks Camp, July 9, 1976 C. P. Bagdonas; Glenwood Springs, July 24–30 [USNM]; Nederlands, June 27, July 7, 1961 M. R. Mac Kay [CNC]; 10 mi. N. New Castle, June 4, 26, 1976 C. P. Bagdonas [CPB]; Rist Canyon, 18 mi. W. Ft. Collins, June 12, 26, 1–76 C. P. Bagdonas [CPB]; Silverton, August 8–15 [USNM]. MICHIGAN: Ogemaw Co., May 25, 1951 J. H. Newman [USNM]; Luzerne, May 31, 1939 G. W. Rawson [USNM]. MONTANA: Cooke City, Park Co., July 27, 1959 F. Rindge [AMNH]. OREGON: Lake Basin, Wallowa Mts., August 15, 1956 J. C. Ham [USNM]. UTAH: Alta, July 6, 1943 & June 28, 1943 V. Nabokov [MCZ]; 25 mi. N. Vernal 8,700′, Uintah Co., July 20, 1963 F. Rindge [AMNH]; Richfield, June 28, 1929 D. E. Fox [CNC]; Vineyard, July 11, 1917 T. Spalding [USNM]. WYOMING: Yellowstone Park, July 8–15 [USNM].

Papestra biren Goeze, new combination

(Figs. 76, 77, 116, 119, 168 and Map 9)

Phalaena noctua biren Goeze, 1781. Ent. Beyträge, 3(3):206.
Type locality: [Europe] [type represented by an illustration by C. F. C. Kleeman *in*: Roesel, A. J. & C. F. C. Kleeman: Der Monatlich herausgegebene Insecten Belustigung, 4:361, and pl. 48, figs. 1–7].
Polia bombycina sensu auct. not Hufnagel, 1766.
Noctua glauca Kleeman, 1792. Beitr. Ins., i, pl. 48, figs. 1–7.
Type locality: [Europe] [see *biren*].
Polia glauca, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:141.
Polia frustrata McDunnough, 1946. Can. Ent., 78:32. NEW SYNONYMY.
Type locality: White Bay, Newfoundland [CNC].
Mamestra frustrata, Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ., Agric. Exp. Sta. Mem., 329:85.
Mamestra biren, Boursin, 1965. Ent. Berichte, 3:128. Dufay, 1975. Entomops, 37:145.
Lacanobia biren, Fletcher, 1972. *in*: Kloet & Hincks, A Check List of British Insects, Royal Ent. Soc. London, 11:75.
Mamestra (*Papestra*) *biren*, Sukhareva, 1973. Ent. Review 52:282.



Map 9.—Geographical distribution of members of *Papestra*.

■ *P. biren* Goeze (Nearctic part of range only) ● *P. quadrata* Smith

Front with black transverse band consisting of simple or bidentate scales; palpi upcurved to middle of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with anterior crest weak or absent, posterior crest present and divided; tegula clothed with 3- and 4-dentate scales; abdomen with tufts on first four segments, those on segments two and three subequal and most prominent; coremata present; forewing with ground gray to violet-gray; ordinary lines and spots present; reniform broad and extremely close to postmedian line at lower, outer angle; W-mark present.

Male genitalia: (Figs. 76, 77) T.L.M. slide no. 130.

Female genitalia: (Fig. 116) T.L.M. slide no. 273.

Alar expanse: 34–39 mm.

Food plant: *Salix Caprea, Caluna vulgaris, Myrica Gale,* lettuce (Stokoe, 1948), *Tussilago* (Hampson, 1905), *Alnus* sp., *Salix* sp., *Larix* (CNC reared specimens).

When first discovered in North America, *P. biren* was treated as a distinct species by McDunnough. In his 1946 paper, McDunnough wrote: "It might be considered a race of *glauca* [= *biren*] but in view of the difference in larval food-plants (that of *glauca* being listed as *Vaccinium*) I prefer to hold it as a good species." Since this time, more reared specimens have been deposited in the Canadian National Collection and alder and willow have been added to the list of natural hosts. The holotype of McDunnough's "*frustrata*" was bred from *Larix*.

With a large sample, I find the slight genitalic differences, mentioned by McDunnough, to overlap with the variation observed in the Palearctic *P. biren*. Only four specimens of European *P. biren* (in the Franclemont collection) have been examined. Several of the North American *P. biren* conform perfectly with specimens from England and Scotland. Many are perhaps closer in general appearance to the sympatric *P. quadrata* than to European specimens.

Apparently, *P. biren* was introduced into Newfoundland in the late 1930's. It spread southward and was recorded in Nova Scotia by D. C. Ferguson in the 1950's. It showed up in Alberta in 1958 (CNC material) and will, in all probability, eventually populate a range similar to *P. quadrata*. *P. quadrata* is its closest relative and time will tell whether the two species will hybridize (so far this has not occurred) or displace one another.

Pierce (1909) describes the bursa: "Bursa small, with long narrow projection. This projection bears the signa, about eight, rounded, scobinate, very small. This is unusual, and raises the question whether these are really signa." I have examined two females (Bury, England and Rannoch, Scotland) and could find no trace of signa, which, of course, is not anticipated if this projection is, in reality, the appendix (see generic discussion). I believe Pierce had prepared a specimen that had mold on the appendix. Molds are often found on the bursa of females and occasionally on the vesica of males, possibly from having been left in a relaxing jar for too long.

Specimens examined were taken from June 10 to July 27.

Specimens examined: 57. ALBERTA: 12 mi. SE. Hinton, January 26, 27, 1958 reared (ex. larch) 57A1742–01 [CNC]; 16 mi. W. Nordegg, January 28, 1958 reared (ex. willow) 57A11977–03 [CNC]; 11 mi. N. Nordegg, January 28, 1958 reared (ex. alder) 57A1979–01 [CNC]. LABRADOR: Cartwright, July 5, 1955 E. F. Cashman [CNC]. NEWFOUNDLAND: St. John's, July 27, 1965 R. F. Morris [CNC]; White Bay, (Forest Ins. Survey 1944/5) bred from larva on *Larix* (Holotype of *frustrata*) [CNC]; Humber, (Forest Ins. Survey 1944/5) bred from Larva on *Larix* [CNC]; St. Gemges (sp?), same breeding data [CNC]; Dawson Rd., Rick Co., (same breeding data) [CNC]; Calinet, (same breeding data) [CNC]; Calinet, June 22, 1962 R. F. Morris [CNC]. NOVA SCOTIA: New Harbor, Guysborough Co., July 13, 1956 D. C. Ferguson [USNM]; Sheet Harbour, Halifax Co., February 23, 1967 reared (ex. Larch) [CNC]; Lake Kejimujik, Queens Co., June 19, 1957 D. C. Ferguson [USNM]; Mt. Uniacke, June 7, 1950, June 22, 1951, June 10, 1953 D. C. Ferguson [USNM]; Bog E. of Big Indian Lake, Halifax Watershed, July 13, 1959, June 12 to June 27, 1963 D. C. Ferguson [USNM].

Papestra cristifera Walker, new combination

(Figs. 78, 79, 82, 117, 122, 169 and Map 10)

Acronycta cristifera Walker, 1858. List Spec. Lep. Ins. Coll. Brit. Mus., 15:1654.

Type locality: St. Martin's Falls, Albany River, Hudson's Bay [BM(NH)].

Mamestra impolita Morrison, 1874. Proc. Boston Soc. Nat. Hist., 17:140. Smith, 1893. Bull. U.S. Natl. Mus., 44:129.

Type locality: Quebec, Canada [not determined].

?*Scotogramma impolita*, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:30.

Mamestra cristifera, Smith, 1893. Bull. U.S. Natl. Mus., 44:121. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:85.

Polia cristifera, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:106, pl. 81, fig. 7. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Front with complete transverse brown band composed of simple scales, frequently with white decumbent scales on lower front; palpi upcurved to lower fourth of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with anterior crest weak and divided, posterior crest present and divided; tegula with considerable hair and 4-, 5- and 6-dentate scales; abdomen with tufts on first five segments, increasing in size to the fourth segment; coremata present; forewing ground dark gray to gray-brown; ordinary lines and spots present; median dash rarely present; reniform usually appearing lighter than orbicular; W-mark present.

Male genitalia: (Figs. 78, 79) T.L.M. slide no. 236.

Female genitalia: (Fig. 117) T.L.M. slide no. 107.

Alar expanse: 34-40 mm.

Food plant: *Alnus sinuata*, *Eucephalus* sp. [both formerly recorded in error as food plant of *P. invalida*]. *Salix rigida* Muhl. [JGF].

Superficially, *P. cristifera* is similar to *P. brenda*. They are readily distinguished by the dissimilar orientation of the clavi of the valves (see figs. 83 and 84). Mr. Alan Hayes of the British Museum dissected the type of *P. cristifera* and provided me with transparencies allowing for positive identification. Of the *Papestra* with a forked seventh sternite of the female, *P. cristifera* is the only species not confined to the West.

Based on distribution and size (Cope's Rule), it is likely that a *P. cristifera*-like ancestor penetrated the West on both sides of the Rocky Mountains. The populations became isolated probably during glacial periods, eventually producing *P. invalida* and *P. brenda*. At present they are sympatric in parts of their range. In the American Museum of Natural History collection, there is a large series of both *P. brenda* and *P. cristifera* collected by Dr. Fred Rindge. He frequently took both species together. On examining his series, there does not appear to be any overlap in the characters of the two species. Some specimens identified as this species in the past proved to be dark *P. brenda*.

From the records available, apparently *P. invalida* and *P. cristifera* have not been taken together. If *P. invalida* spreads northward, it will be interesting to see if it interbreeds with *P. cristifera*. Both species possess coremata, used during courtship, and subtle differences in the secretion may provide for a behavioral isolating mechanism.

Specimens examined were taken May 22 to August 14.

Specimens examined: 78. ALBERTA: Banff [USNM]; Calgary, May 9, 1915 & March 21, 1915 (reared) F. H. Wolley Dod [USNM]; Nordegg, June 12, 29, & 30, 1921 [USNM]. BRITISH COLUMBIA: Aspen Groove, June 23, 1934 H. B. Leech [CNC]; Fernie, May 30, 1936 H. Leech [CNC]; Kaslo, July 1, 1905 J. Cockle [LACM]; Oliver, 1,000′, July 10, 1953 D. F. Hardwick [CNC]; Osoyoos [CNC]; Diamond Head Trail, Garibaldi Peak, 3,200′, nr. Squamish, August 3, 8, 1953 S. D. Hicks [CNC]. NEW BRUNSWICK: Squaws Cap, July 10, 1960 D. C. Ferguson [USNM]. NEWFOUNDLAND: Doyles, Codroy Valley, July 6, 9, 28, 30, 31, 1962 D. C. Ferguson [USNM]. ONTARIO: Nakina, June 27, 28, 1960 J. C. E. Riotte [AMNH]; Geraldton, June 12, 1953, June 12, 1957, July 13, 1952, June 20, 1956, June 21, 1957 J. C. E. Riotte [AMNH]; Nipigon, June 19, 1958 J. C. E. Riotte [AMNH]; Smoky Falls, Mattagami R., June 23, 1934 G. S. Walley [CNC]. QUEBEC: Seven Isles, September 10, 1924 (reared?) F. W. Waugh [CNC]. COLORADO: Glenwood Springs, August 1-7, June 8-15 [USNM]; Davenport Campground, 36 mi. S. Florence, 8,500′, Custer Co., July 1, 1967 F. & P. Rindge [AMNH]; St. Louis Crk. Campground., 3 mi. SW. Fraser, Grand Co., July 25, 30, 1967 F. & P. Rindge [AMNH]; 5 mi. SW. Fraser, Grand Co., 8,800′, July 27, 29, 1967 F. & P. Rindge [AMNH]; Hermosa, La Plata Co., July 8, 1959 C. L. Hogue [LACM]; Oslar, Sneffels Mts., Ouray Co., August [USNM]; Steamboat Springs, Routt Co., July 28, 1962 J. S. Buckett [DAVIS]; Valley View Lodge, 10 mi. S. Steamboat Springs, Routt Co., 7,000′, July 13, 1956 & July 14, 16, 17, 1957 & July 27, 1967 F. & P. Rindge [AMNH]; Glenwood Springs, July 24–30 [USNM]; Durango, July 8–15 [USNM]. IDAHO: Badger Creek, 3,500′, Idaho Co., July 4, 1976 T. L. McCabe [TLM & JGF]. MONTANA: Glacier Natl. Pk., July 12, 1920 E. H. Nast [CAS]. WASHINGTON: Mt. Rainier, July 1904 [USNM]; Tipsco Lake, March 28, 1939 (reared) [USNM]; White River Campground., Mt. Rainier, March 28, 1939 (reared) & May 3, 1939 (reared) S. E. Crumb [USNM]; Indian Flat, May 22, 1938 S. E. Crumb [USNM]; Rainier Nat. Pk., July 17, 1936 E. C. Van Dyke [CAS]. WYOMING: Willow Crk. R. S., 20 mi. N. Pinedale, Sublette Co., 8,000′, July 19, 1955

R. H. Leuschner [RHL]; E. Jenny L., Grand Teton Nat. Pk., July 13, 1955 F. Hartig [AMNH]; Madison Jct. Cp., Yellowstone Natl. Pk., 7,000′, August 14, 1972 R. H. Leuschner [RHL]; Yellowstone Nat. Pk., 7,800′, July 15, 1953 F. Hartig [AMNH].

Papestra brenda Barnes & McDunnough, new combination

(Figs. 83, 85, 86, 121, 170–172 and Map 10)

Polia (Mamestra) brenda Barnes & McDunnough, 1916. Contri. Nat. Hist. Lep. N.A., 3:7.
Type locality: Stockton, Utah [USNM].
Polia brenda, McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Front with partial or complete transverse band; palpi upcurved to middle of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with weak and divided anterior and posterior crests; tegula clothed with 2- and 3-dentate scales and considerable hair; abdomen with tufts on first four segments, those on segments two and three the largest; coremata present; forewing ground light gray to sooty gray; median dash usually present; reniform and orbicular the same shade; W-mark present.

Male genitalia: (Figs. 81, 85, 86) U.S.N.M. slide no. 1962.

Female genitalia: (Fig. 121) T.L.M. slide no. 295.

Alar expanse: 35-41 mm.

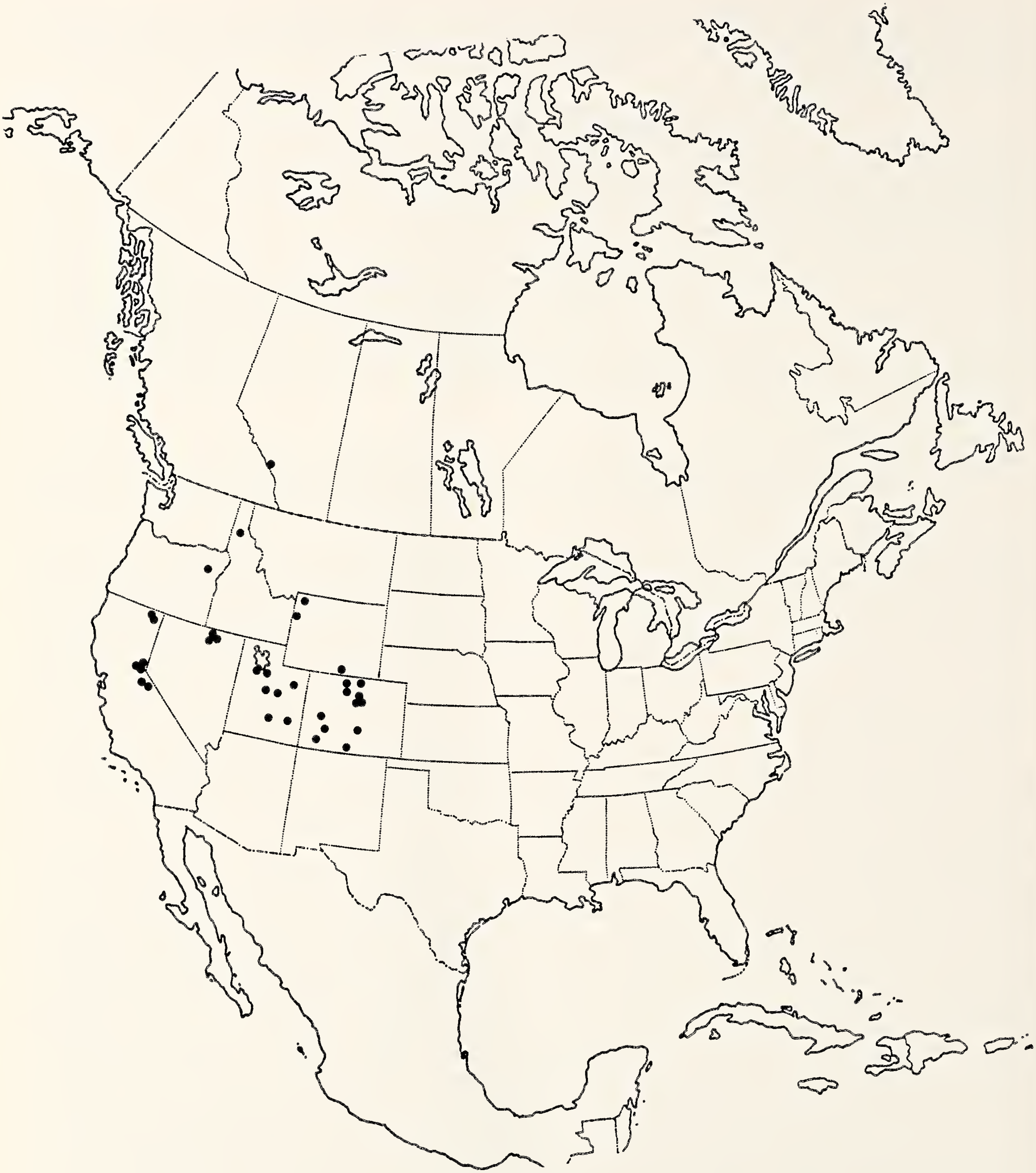
Food plant: "Clover and other low plants" (Crumb, 1956). Because of confusion with *cristifera* and *invalida*, a more complete list of food plants is not possible. The above food plants were reported by Crumb for *cristifera*, but the specimen identified as *cristifera* was actually *brenda*.

Papestra brenda from the type locality are usually light colored (fig. 171) compared to specimens from the northern part of the species range (fig. 170). This had led to the mixing of *P. brenda* and *P. cristifera* in collections. The two species are sympatric over much of their range, but only *P. cristifera* occurs in the East. The distinguishing structural difference is the angle of the clavi in the male genitalia. I have provided drawings to elucidate this feature (figs. 83 and 84). Females are indistinguishable on the basis of genitalia, but can be sorted with some exceptions on the basis of the projections of the seventh sternite. In *P. brenda*, the projections appear irregular and rough; in *P. cristifera* the projections are cylindrical and comparatively smooth. The pattern of *P. cristifera* is somewhat more contrasty.

I believe Crumb's (1956) description of the larva of *P. cristifera* pertains to *P. brenda*; I have examined Crumb's reared adults of *invalida* and they were misidentified specimens of *cristifera*. I was able to verify the identity of the larva of *cristifera* from larvae reared by J. G. Franclemont from two females I collected in Idaho. Godfrey's (1972) *P. cristifera* description, based on Crumb's material, also pertains to *P. brenda*.

Specimens examined were taken May 27 to August 11.

Specimens examined: 104. ALBERTA: Canmore, 4,300′, (SE. Banff), June 15, 1963 N. Westerland [LACM]. BRITISH COLUMBIA: Nicola, June 18, 1922 P. N. Vroom. CALIFORNIA: Nevada Co., [LACM]; 10 mi. SW. Eagleville, Modoc Co., July 5, 1962 Buckett & Trenam [DAVIS]; Lasser Creek, Modoc Co., June 11, 1962 Buckett & Trenam [DAVIS]; Rock Creek, 8,000′, Mono Co., June 15, 1968 R. H. Leuschner [RHL]; White Mts., 10,500′, Mono Co., July 6, 1962 Manis & Mathlis [DAVIS]; 8 mi. N. Leevining, Mono Co., June 25, 1962 Buckett & Bauer [DAVIS]; 2 mi. S. Tahoe City, Placer Co., May 27 & June 5, 1966 N. Westerland [LACM]; Deer Park Springs, Lake Tahoe [USNM]; COLORADO: 3 mi. N. Combres, 10,000′, Conejos Co., July 9, 1967 F. & P. Rindge [AMNH]; 36 mi. S. Florence, Custer Co., 8,500′, July 1, 1967 F. & P. Rindge [AMNH]; St. Louis Crk., Camp, 3 mi. SW. Fraser, 8,800′, Grand Co., July 25, 29, & 30, 1967 F. & P. Rindge [AMNH]; 5 mi. SW. Fraser, 8,900′, Grand Co., July 29, 1967 F. & P. Rindge [AMNH]; Lake City, 8,684′, Hinsdale Co., July 3, 1957 F. & P. Rindge [AMNH]; Big Thompson Canyon, 6,500′, Larimer Co., June 9, 1954 R. H. Leuschner [RHL]; 16 mi. SW. Montrose, Montrose Co., 7,800′, June 24, 1957 F. & P. Rindge [AMNH]; 10 mi. S. Steamboat Springs, Routt Co., 7,600′, July 16, 1957 F. & P. Rindge [AMNH]; Denver, June 18, 1958 R. Jae [RHL]; Durango, July 8–15 [USNM]; Estes Park, 11,600′, July 28, 1967 D. F. Hardwick [CNC]; Nederland, 8,300′, July 1, 1961 M. R. MacKay [CNC]. IDAHO: Wallace, July 1, 1940 O. Huellemann [AMNH]. NEVADA: Pine Crk., Jarbridge Mts., Elko Co., June 27, 1967 J. Lane [RHL]; Angel Lake, 8,200′, E. Humboldt Mts. nr. Wells, Elko Co., July 14, 23, 1971 D. C. Ferguson [USNM]; Angel Lake, 7,000′, E. Humboldt Mts., nr. Wells, Elko Co., July 13, 18, 21, 1971 D. C. Ferguson [USNM]; Ruby Mts., June 23, 1959 T. Davies [LACM]; Ruby Mts., July 7, 1958 [LACM]; Snake



Map 10.—Geographical distribution of *Papestra brenda* Barnes & McDunnough.

Range, 11,000′, July 31, 1967 Emmel & Shields [LACM]. OREGON: Spring Creek nr. Baker, Baker Co., 4,000′, July 26, 1956 J. Baker [AMNH]. UTAH: Alta, July 29, 1943 V. Nabokov [MCZ]; Reeder Canyon, Jose Vly. Res., Emery Co., July 11, 1971 D. C. Ferguson [USNM]; Blue Spruce Camp., 18 mi. N. Escalante, Garfield Co., 8,000′, July 1, 2, 4, 5, 1963 F. & P. Rindge [AMNH]; 5 mi. W. Monticello, San Juan Co., 8,500′, July 14–15, 1963 F. & P. Rindge [AMNH]; 25 mi. N. Vernal, Uintah Co., 8,700′, July 19–20, 1968 F. & P. Rindge [AMNH]; Stockton, August 11, 1914 T. Spalding [USNM]. WASHINGTON: Signal Park R. S., June 21, 1933 (reared) S. E. Crumb [USNM]. WYOMING: Bottle Creek Camp, 7 mi. SW. Encampment, Carbon Co., 8,800′, August 2, 5, 1967 F. & P. Rindge [AMNH]; Mt. Washburn, Yellowstone Nat. Pk., 10,317′, July 14, 1955 F. Hartig [AMNH]; Yellowstone Nat. Pk., 7,800′, July 10, 15, 17, 1955 Hartig [AMNH]; E. Jenny Lake, Grand Teton Natl. Pk., 6,849′, July 13, 1955 Hartig [AMNH].

Papestra invalida Smith, new combination

(Figs. 80, 81, 123, 173 and Map 11)

Mamestra invalida Smith, 1891. Proc. U.S. Natl. Mus., 14:225. Smith, 1893. Bull. U.S. Natl. Mus., 44:119.

Type locality: Sierra Nevada, California; Placer Co., California [USNM].

Polia invalida, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:96, pl. 80, fig. 31. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Front with complete transverse dark brown band composed of simple scales; palpi upcurved to middle of front; male antennae simple, segments unisetose on each side; female antennae similar, but with shorter setae; thorax with a weak divided anterior crest and a well-developed divided posterior crest; tegula clothed with 2-, 3-, 4-, and 5-dentate scales and considerable hair; abdomen with tufts on first four segments, those of two and three most prominent; coremata present; forewing with ground dark silvery-gray; wings with ordinary lines and spots present; median dash present; reniform and orbicular the same shade; W-mark present.

Male genitalia: (Figs. 80, 81) T.L.M. slide no. 287.

Female genitalia: (Fig. 123) T.L.M. slide no. 288.

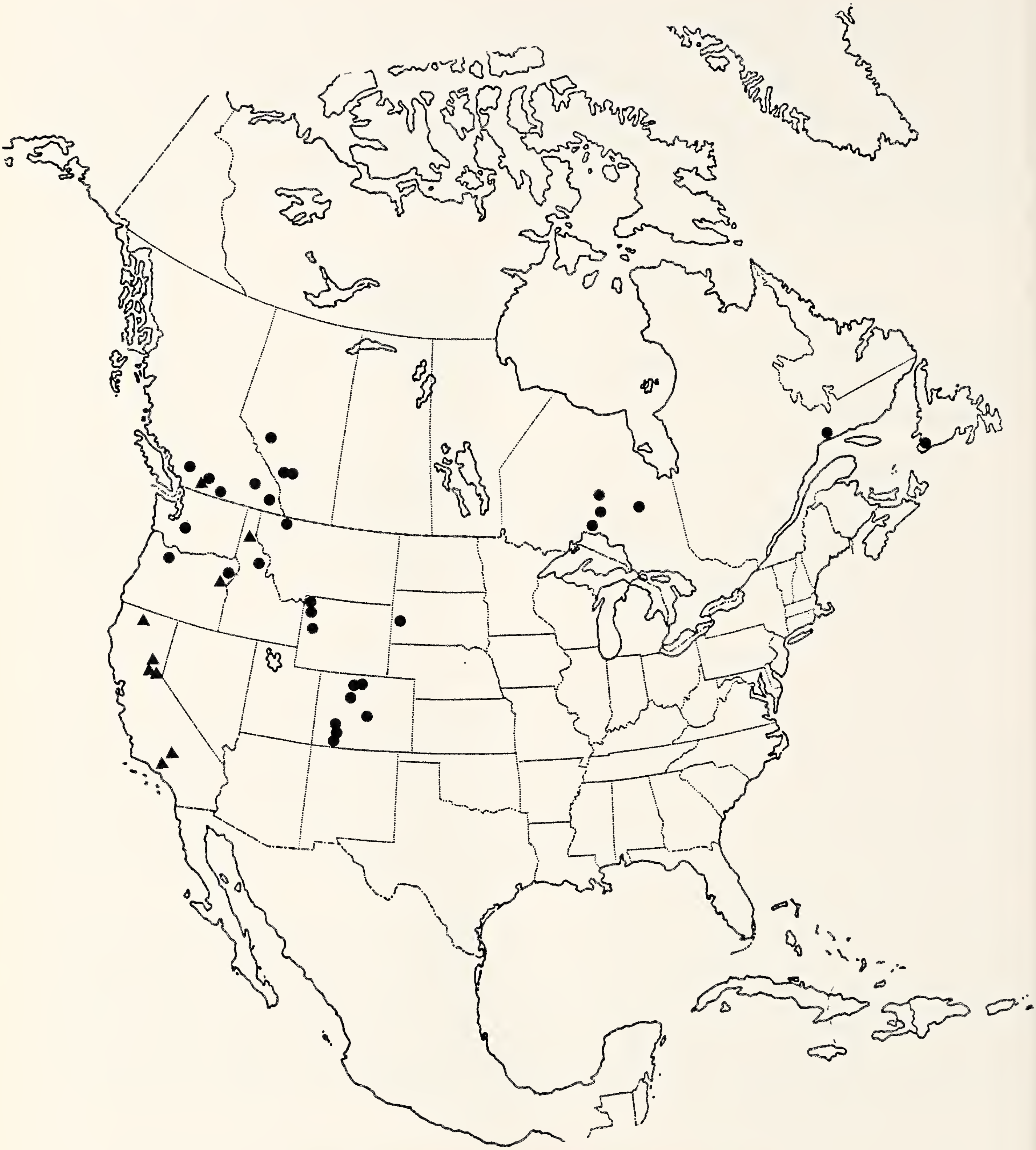
Alar expanse: 38-50 mm.

Food plant: *Ribes cereum* (from CNC reared material). Crumb's reared *invalida* were *P. cristifera*.

P. invalida is the largest species in the genus. I have examined Crumb's reared specimens, determined as "*invalida*"; they were *P. cristifera*. He reared two species of *Papestra*; the larvae determined as "*invalida*" (by association) were described as brown in color; the other species was described as gray. I collected females of *P. cristifera* in Idaho whose progeny were reared on *Salix rigida* by Franclemont. These larvae agree with Crumb's description of "*invalida*." The larvae of *cristifera* of Crumb (also treated as *cristifera* by Godfrey) I believe to be *P. brenda* judging from their size. However, reared adults of Crumb's *cristifera* were not found nor is it known where any are deposited. Much of Crumb's material was returned to him and the Crumb collection went to the United States National Museum, but no specimens from the locality of his *cristifera* were found.

Specimens examined were taken April 7 to July 24.

Specimens examined: 32. BRITISH COLUMBIA: Hedley, March 21, 1966 (reared on *Ribes cereum*) [CNC]. CALIFORNIA: Buckhorn Flats, 6,500′, Los Angeles Co., June 1, 1963 R. H. Leuschner [RHL]; Sagehen Creek, Nevada Co., July 6, 1962 R. L. Westcott [LACM]; Placer Co., May, June [CAS]; 2 mi. S. Tahoe City, Placer Co., May 19 through June 10, 1966 N. Westerland [LACM]; Johnsville, Plumas Co., May 20, 1966 R. H. Leuschner [RHL]; 4 mi. SW. Johnsville, Plumas Co., June 5, 1966, June 11, 1961, July 6, 16, 1962 Buckett & Bauer [DAVIS]; Wrightwood, 6,100′, San Bernadino Co., July 7, 12, 1964 C. A. Hill [USNM]; Mt. Shasta, 6,500′, July 24, 1965 E. Munroe [CNC]; Lake Tahoe, June 23, 1927 E. H. Nast [CAS]. IDAHO: Wallace, April 7, 1938 O. Huellemann [JGF]; Wallace, May 19, 24, 29, 1940 O. Huellemann [AMNH]. OREGON: Spring Crk., Baker Co., June 22, 1959 J. H. Baker [RHL].



Map 11.—Geographical distribution of members of *Papestra*.

● *P. cristifera* Walker ▲ *P. invalida* Smith

ANNOTATED LIST OF THE NORTH AMERICAN *POLIA* AND RELATED GENERA

This list follows the systematic arrangement used in this paper. Synonyms are in italics and subspecies are preceded by a small letter.

- Polia Ochsenheimer, 1816
  - piniae Buckett & Bauer, 1967
  - discalis Grote, 1877
  - nimbosa Guenée, 1852
    - a. mystica Smith, 1898
    - b. mysticoides Barnes & Benjamin, 1924
  - imbrifera Guenée, 1852
  - rogenhoferi Möschler, 1870
    - *leomegra Smith, 1908*
    - form carbonifera Hampson, 1908
  - propodea sp. nov.
  - richardsoni Curtis, 1835
    - *algida Lefebvre, 1836*
    - *septentrionis Walker, 1857*
    - *feildeni M'Lachlan, 1878*
    - *asiatica Staudinger, 1901*
    - *dovrensis Staudinger, 1901*
    - a. squara Smith, 1908
    - b. magna Barnes & Benjamin, 1924
    - c. tamsi Benjamin, 1933
    - d. groenlandica Heydemann, 1944
    - e. lanuginosa Smith, 1900
  - purpurissata Grote, 1834
    - *juncimacula Smith, 1900*
    - *crydina Dyar, 1904*
    - a. languida Smith, 1893
    - b. apurpura Barnes & McDunnough, 1913
  - nugatis Smith, 1898
    - *tufa Smith, 1905*
- Melanchra Hübner, [1820] 1816
  - adjuncta Boisduval, 1841
    - *declarata Walker, 1856*
    - form benjamini Lemmer, 1937
  - picta Harris, 1841
    - *exusta Guenée, 1852*
    - *contraria Walker, 1856*
  - pulverulenta Smith, [1888] 1887
  - assimilis Morrison, 1874

- Spiramater, gen. nov.
  - lutra Guenée, 1852
    - *lubens Grote, 1875*
    - *rufula Morrison, 1875*
    - a. glaucopis Hampson, 1905
  - grandis Guenée, 1852
    - *grandis Boisduval, 1840* nomen nudum
    - *grandis Guenée, 1841* nomen nudum
    - *libera Walker, 1856*
- Lacanobia Billberg, 1820
  - subjuncta Grote & Robinson, 1868
    - a. eleanora Barnes & McDunnough, 1918
  - nevadae Grote, 1876
    - *canadensis Smith, [1888] 1887*
  - atlantica Grote, 1874
    - *discolor Speyer, 1875*
  - radix Walker, [1857] 1856
    - *dimmocki Grote, 1875*
    - *desperata Smith, 1891*
- Trichordestra, gen. nov.
  - rugosa Morrison, 1875
  - tacoma Strecker, 1900
  - legitima Grote, 1864
  - dodii Smith, 1904
  - beanii Grote, 1877
  - lilacina Harvey, 1874
    - a. luski Barnes & McDunnough, 1913
    - form illebefacta Morrison, 1874
  - liquida Grote, 1881
    - a. meodana Smith, 1910
  - prodeniformis Smith, [1888] 1887
- Papestra Sukhareva, 1973
  - quadrata Smith, 1891
    - a. ingravis Smith, 1895
  - biren Goeze, 1781
    - *glauca Hübner, 1808–9*
    - *bombycina sensu auct. not Hufnagel, 1766*
    - *frustrata McDunnough, 1946*
  - cristifera Walker, 1858
    - *impolita Morrison, 1874*
  - brenda Barnes & McDunnough, 1916
  - invalida Smith, 1891

MISCELLANEOUS SPECIES PLACED IN "*POLIA*" IN MCDUNNOUGH'S 1938 CHECKLIST

The Moths of North America project is producing a new checklist of the Lepidoptera. It is anticipated that both the present work and the new checklist will be published within months of each other. Since the species covered in this final section are also being moved into existing genera by the author's of the checklist, I have illustrated and discussed the relationships of these species, but have not made recombinations. The new combinations will appear in the Moths of North America checklist.

"Polia" latex Guenée

(Figs. 174, 175, 197, 198)

Aplecta latex Guenée, 1852. Hist. Nat. Ins. (Lépid.), 6:78.
Apamea demissa Walter, 1857. Cat. Lep. Het. Brit. Mus., 11:728.
Mamestra latex, Smith, 1893. Bull. U.S. Natl. Mus., 44:121. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:86.
Polia latex, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:112, pl. 81, fig. 12. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Male genitalia: (Figs. 174, 175) T.L.M. slide no. 68.

Latex is related to *Morrisonia mucens* Hübner and *M. evicta* Grote and the male genitalia are similar. The genitalia of *mucens* and *evicta* are partially illustrated by Smith, 1892. The female genitalia of *latex* appear to differ and placement with these may only be temporary. In *latex* the antennal segments are not unisetose on each side and are unlike all the species studied in the *Polia* complex.

Tarsal spinules from three rows in *latex*, resembling those of *M. evicta* and *M. mucens*. The antennae are also similar, although in *M. evicta* the antennae are doubly serrate. Godfrey (1972) found the larvae of *M. evicta* and *latex* to be very close, sharing spinnerets that are twice the length of the first segment of the labial palpi.

Distribution: Quebec to mountains of Virginia, west to southern Ontario and central New York (Forbes, 1954).

"Polia" purpurea Barnes & McDunnough

(Figs. 176, 177, 199)

Polia purpurea Barnes & McDunnough, 1910. Jour. New York Ent. Soc., 18:151. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Male genitalia: (Figs. 176, 177) U.S.N.M. slide no. 1938 (Holotype).

Purpurea is extremely close to *Egira* (= *Xylomyges*) *perlubens* Grote and, like *perlubens*, it has four rows of tarsal spinules. One specimen examined bears the date "Jan. 31" indicating a very early flight period for this species.

Distribution: known only from Palmerlee, Arizona.

"Polia" segregata Smith

(Figs. 178, 179, 200)

Mamestra segregata Smith, 1893. Ent. News, 4:100, pl. 6, fig. 11. Dyar, [1903] 1902. Bull. U.S. Natl. Mus., 52-:155. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:86.
Mamestra gussata Smith, 1895. Ent. News, 6:337, pl. 15, fig. 9.
Mamestra plicata Smith, 1898. Ent. News, 9:243.
Mamestra negussa Smith, 1900. Can. Ent., 32:219, pl. 5, fig. 2.
Polia segregata, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:146, pl. 82, fig. 16. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

Male genitalia: (Figs. 178, 179) T.L.M. slide no. 140.

Segregata is extremely variable. It has relatively simple valves, and belongs to the same species group as *Orthosia revicta* Morr. with which it agrees in characters of the vesica, such as the branching, the raised "cluster of spines," and a bulbed cornutus. Godfrey (1972) placed it between *Morrisonia* and *Xylomyges.*

Distribution: Ottawa, Ontario, Manitoba and west (Forbes, 1954).

"*Polia*" *goodelli* Grote

(Figs. 180, 181, 201)

Mamestra goodelli Grote, 1875. Can. Ent., 7:223. Smith, 1893. Bull. U.S. Natl. Mus., 44:124. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:87.

Mamestra acutermina Smith, 1904. Can. Ent., 36:153.

Polia goodelli, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:153, pl. 82, fig. 17. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Male genitalia: (Figs. 180, 181) T.L.M. slide no. 4.

This species appears to show some relationship to *Orthodes cynica.*

Distribution: New Brunswick and St. Hilaire, Quebec to North Carolina, west to Alberta and New Mexico (Forbes, 1954).

"*Polia*" *obscura* Smith

(Figs. 182, 183, 201)

Mamestra obscura Smith, 1887 [1888]. Proc. U.S. Natl. Mus., 10:468. Smith, 1893. Bull. U.S. Natl. Mus., 44:124. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:87.

Polia obscura, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:157, pl. 82, fig. 23. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Male genitalia: (Figs. 182, 183) T.L.M. slide no. 22.

Obscura also shows similarity to *Orthodes cynica.*

Distribution: Meach Lake, Quebec, Ontario generally, north to Smoky Falls, west to eastern British Columbia, south to Arizona (Forbes, 1954).

"*Polia*" *nipana* Smith

(Figs. 184, 185, 203, 204)

Mamestra nipana Smith, 1910. Jour. New York Ent. Soc., 18:93.

Polia nipana, McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Male genitalia: (Figs. 184, 185) T.L.M. slide no. 291.

This species is similar in male genitalia to *Hexorthodes serrata* (Smith) whose genitalia are illustrated by McDunnough (1943).

"*Polia*" *montara* Smith

(not illustrated)

Mamestra montara Smith, 1910. Jour. New York Ent. Soc., 18, 94.

Polia montara, McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

This species is clearly congeneric with *Hexorthodes nipana* and may even prove to be conspecific.

"Polia" tuana Smith

(Figs. 186, 187, 205)

Mamestra tuana Smith, 1906. Can. Ent., 38:229.
Polia tuana, McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Male genitalia: (Figs. 186, 187) T.L.M. slide no. 285.
This species is more closely related to *Hexorthodes* than to the *Polia* complex.

"Polia" vau-orbicularis Smith

(not illustrated)

Mamestra vau-orbicularis Smith, 1902. Jour. New York Ent. Soc., 10:42.
Polia vau-orbicularis, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:102. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

This species and the two following are congeneric and are very closely related to one another.

"Polia" noverca Grote

(Figs. 188, 189, 206)

Mamestra noverca Grote, 1878. Can. Ent., 10:236. Dyar, 1902 [1903]. Bull. U.S. Natl. Mus., 44:124.
Polia noverca, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:155, pl. 82, fig. 20. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Male genitalia: (Figs. 188, 189) T.L.M. slide no. 212.
The male valves of *noverca* suggest *Homorthodes dubia* Barnes & McDunnough (illustrated in McDunnough, 1943), but the vesica of *noverca* lacks the enlarged spine typical of *Homorthodes* species.

"Polia" delecta Barnes & McDunnough

(not illustrated)

Polia (Mamestra) delecta Barnes & McDunnough, 1916. Contri. Nat. Hist. Lepid. N.A., 3:7, pl. 1, fig. 17.
Polia delecta, McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Crumb (1956) indicated in his key of the Hadenines that *delecta* was worthy of generic rank. Godfrey, 1972, found three additional characters that separate this species from *Polia* and all other hadenine genera: "(1) The adfrontal suture converges very close to the frontal suture below AF-1 and appears to end on that suture laterad of F-1 (fig. 23); (2) the inner ridges of the left mandible terminate at the apices of the outer teeth; and (3) the proximolateral region of the hypopharynx bears three to four rows of large stout spines."

"Polia" detracta Walker

(Figs. 190, 191, 207)

Hadena detracta Walker, 1857. List Spec. Lep. Ins. Coll. Brit. Mus., part 11, p. 752.
Mamestra claviplena Grote, 1873. Bull. Bufalo Soc. Nat. Sci., 1:194.
Mamestra detracta, Smith, 1893. Bull. U.S. Natl. Mus., 44:116. Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:88.
Mamestra neoterica Smith, 1898. Ent. News, 9:244.
Polia detracta, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:65, pl. 80, fig. 6. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Male genitalia: (Figs. 190, 191) T.L.M. slide no. 46.
This species has some resemblance to species of *Homorthodes* and *Protorthodes,* but the absence of a spine-like

cornutus on the vesica and the heavily serrate male antennae (a secondary sexual character) seem to preclude placement in either genus.

"Polia" secedens Walker

(Figs. 192, 193, 208)

Plusia secedens Walker, 1857 [1858]. List Spec. Lep. Ins. Coll. Brit. Mus., 12:913.
Anarta secedens, Smith, 1893. Bull. U.S. Natl. Mus., 44:294.
Polia secedens, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:193, pl. 84, fig. 2. McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.
Mamestra secedens, Forbes, 1954. Lepidoptera of New York and neighboring states, Cornell Univ. Agric. Exp. Sta. Mem., 329:85.

Male genitalia: (Figs. 192, 193) T.L.M. slide no. 150.

Secedens is very close to *Anartomima bohemanni* Stgr. *Anartomima* was proposed by Boursin as a replacement name for *Pseudanarta* Kozhanchikov (preoccupied by *Pseudanarta* Henry Edwards) as a monobasic genus with *bohemanni* as genotype. The valves of the species of *Anartomima* closely resemble those of *Anhimella contrahens* Wlk., however, the vesica lacks the enlarged, single spine McDunnough (1943) mentions in his description of *contrahens*. *Anartomima* shows many similarities to other Hadenine genera.

"Polia" basivirida Barnes & McDunnough

(Figs. 195, 209)

Polia (Mamestra) basivirida Barnes & McDunnough, 1911. Jour. New York Ent. Soc., 19:154-5.
Polia basivirida, McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.

Male genitalia: (Fig. 195) U.S.N.M. slide no. 1969 (Holotype).

Except for the uncus, the genitalia of this species are similar to those of the species of *Pseudanarta*.

The following species of *Polia sensu* McDunnough (1938) have already been placed as follows:

Lacinipolia naevia Smith

(not figured)

Mamestra naevia Smith, 1898. Ent. News, 9:248. Dyar, 1902 [1903]. Bull. U.S. Natl. Mus., 52:156.
Polia naevia, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:65, pl. 80, fig. 6. McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.
Lacinipolia naevia, McDunnough, 1943. Can. Ent., 75:44.

McDunnough (1943) states: "This species [*naevia*] . . . proves to be a *Lacinipolia* belonging to the *gnata* group. I surmised this after a study of the holotype . . . .".

Lacinipolia falsa Grote

(not figured)

Perigea falsa Grote, 1889. Can. Ent., 12:215. Smith, 1893. Bull. U.S. Natl. Mus., 44:153.
Polia falsa, McDunnough, 1938. Mem. S. California Acad. Sci., 1:70.
Lacinipolia falsa, Hampson, 1906. Cat. Lep. Phal. Brit. Mus., 6:388.

Hampson noted that the male type of Grote's *falsa* has hairy eyes, contrary to Grote's own description of *falsa*. Hampson thereupon redescribed Grote's female type without the hair on the eyes as *Bryomima fallax*. Hampson's footnote on *falsa* Grote (p. 388) is quoted as follows: "The ♂ is a *Polia* with serrate antennae allied to *canites*, Hmpsn., and *leucogramma*, Grote." The type male of *falsa* was from Henry Edwards and bears his number 6888. Both *canites* Hampson and *leucogramma* Grote are placed in *Lacinipolia*, therefore, *falsa* is effectively moved with them to *Lacinipolia*, and the move credited to McDunnough.

L. falsa is very close to *L. leucogramma* and there appear to be more names available than species involved.

Graphania mutans Walker

(Fig. 210)

Hadena mutans Walker, 1857, *in* Hudson, New Zealand Moths & Butterflies, p. 18, pl. 3, fig. 15 & pl. 4, figs. 34-6.
Mamestra passa Morrison, 1874. Proc. Boston Soc. Nat. Hist., 17:139. Smith, 1893. Bull. U.S. Natl. Mus., 44:122.
Morrisonia mutans, Hampson, 1905. Cat. Lep. Phal. Brit. Mus., 5:369, pl. 85, fig. 21.
Polia passa, McDunnough, 1938. Mem. S. California Acad. Sci., 1:69.

The type of "*passa*" Morrison was erroneously labeled "Cal." and was determined by J. G. Franclemont as this New Zealand species.

Homorthodes reliqua Smith

(not figured)

Polia gracea Sperry, 1938. Can. Ent., 70:142.
Homorthodes reliqua, McDunnough, 1943. Can. Ent., 75:53.

McDunnough, in 1943, when he proposed the genus *Homorthodes*, synonymized *gracea* Sperry under *reliqua* Smith and placed it in his new genus. At the time of its description it was known from females only, and when males became available, McDunnough was able to assign it to its correct genus.

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Legend For Genitalia Terminology Used In Text

aedeagal spur [as], fig. 35.
aedeagus [ae], fig. 15.
ampullae [am], fig. 13.
anal loop (excavation below cucullus) [al], fig. 59.
anal spine [asp], fig. 14.
anal tube [atb], fig. 10.
anterior apophyses [aa], fig. 87.
apical tuft (of lower margin of valve) [at], fig. 22.
appendix (= appendix bursae) [apx], fig. 89.
bandlike signa [bb], fig. 89.
basal tuft (of lower margin of valve) [bt], fig. 14.
brush (of coremata) [br], fig. 196.
bulbed cornutus [bc], fig. 42.
bursa (= bursa copulatrix) [b], fig. 88.
clavus [cl], fig. 14.
coremata [cta], fig. 196.
cornuti [cor], fig. 11.
costa [co], fig. 37.
costal process [cp], fig. 37.
costal process of cucullus [cpc], fig. 56.
cucullus [cu], fig. 14.
digitus [di], fig. 53.
ductus bursa [db], fig. 88.
ductus seminalis [ds], fig. 88.
free clavus [fc], fig. 53.
juxta [ju], fig. 13.
lever (of coremata) [lv], fig. 196.
ovipositor valves [ov], fig. 87.
penicullar hairs [ph], fig. 10.
pocket (of coremata) [p], fig. 196.
posterior apophyses [pa], fig. 87.
process of costa [pc], fig. 72.
process of sacculus [psa], fig. 53.
sacculus [sac], fig. 53.
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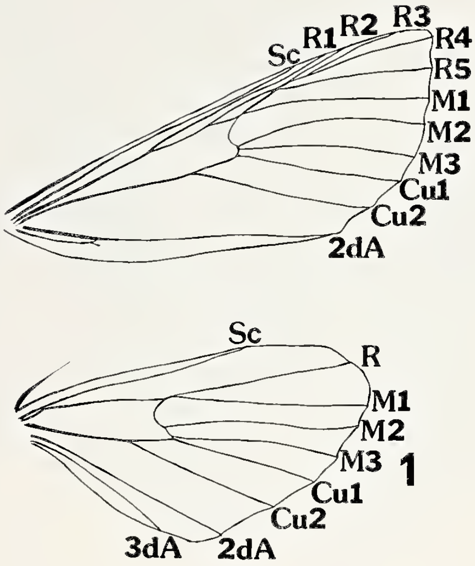
subscaphium [ssc], fig. 53.
uncus [un], fig. 13.
valve [va], fig. 13.
vesica [ve], fig. 15.

FIGURES

VENATION

1 — *Polia discalis* Grote
2 — *Trichordestra legitima* Grote
3 — *Papestra quadrata* Smith
4 — *Polia imbrifera* Guenée
5 — *Spiramater grandis* Boisduval
6 — *Spiramater lutra* Guenée
7 — *Melanchra picta* Harris
8 — *Melanchra adjuncta* Boisduval
9 — *Lacanobia atlantica* Grote



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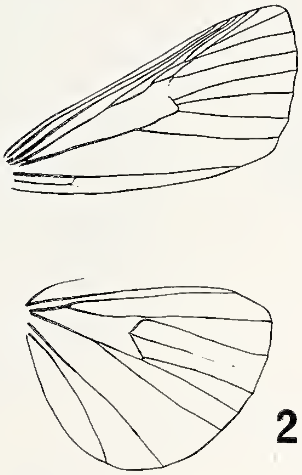

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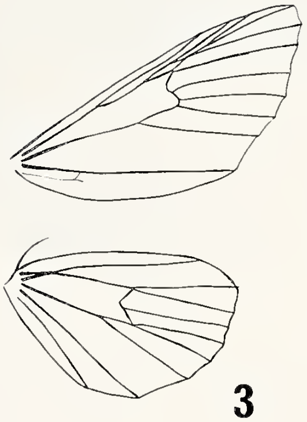

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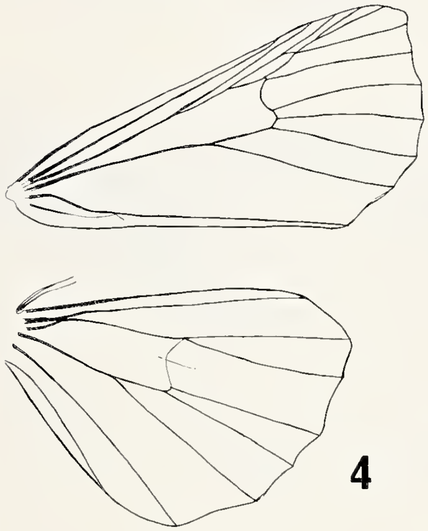

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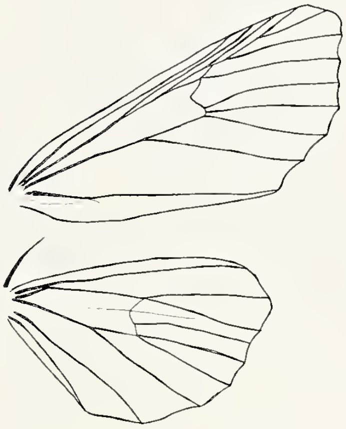

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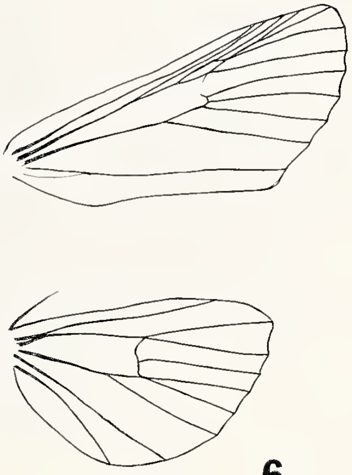

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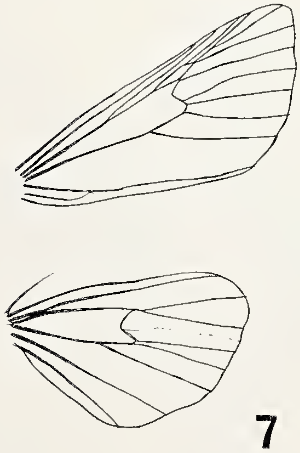

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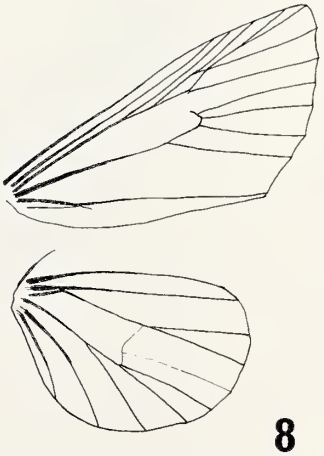

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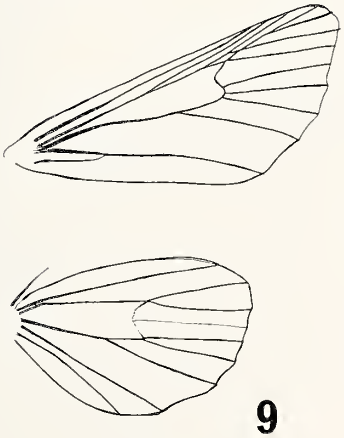


9

MALE GENITALIA

10 — *Polia imbrifera*, valves, Slope Co., North Dakota, slide no. 194 [TLM].
ph, penicula hairs; atb, anal tube.

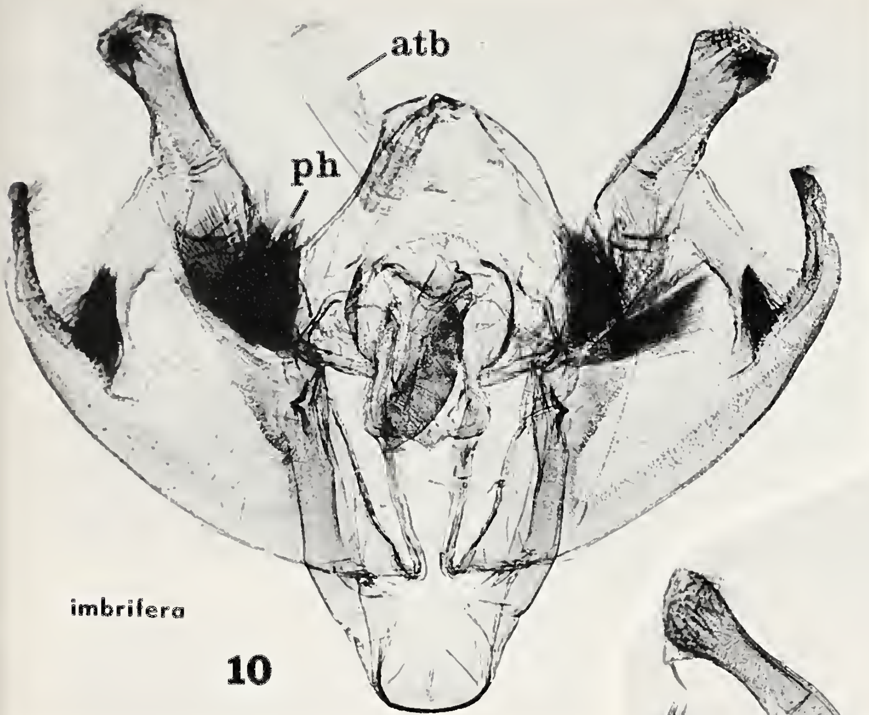
11 — *Polia imbrifera*, aedeagus with vesica everted, same data [TLM].
cor, cornuti.

12 — *Polia nimbosa*, aedeagus with vesica everted, Becker Co., Minnesota, slide no. 218 [TLM].

13 — *Polia nimbosa*, valves, same data [TLM].
un, uncus; am, ampullae; va, valve; ju, juxta.

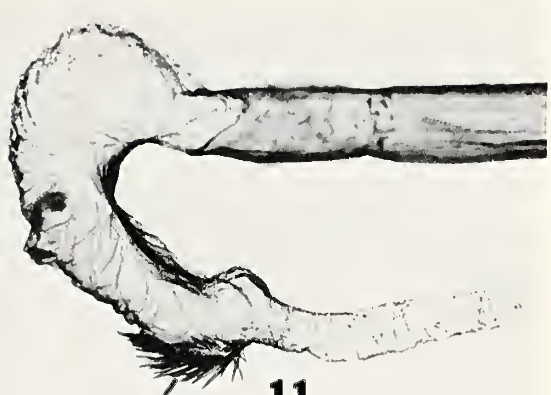
14 — *Polia nimbosa* subspecies *mysticoides*, valves, Wellington, British Columbia, slide no. 14 [USNM].
cl, clavus; bt, basal tuft (of lower margin of valve); asp, anal spine.

15 — *Polia nimbosa*, subspecies *mysticoides*, aedeagus with vesica everted, same data [USNM].
sa, strengthening arch; ve, vesica; ae, aedeagus.



imbrifera

10



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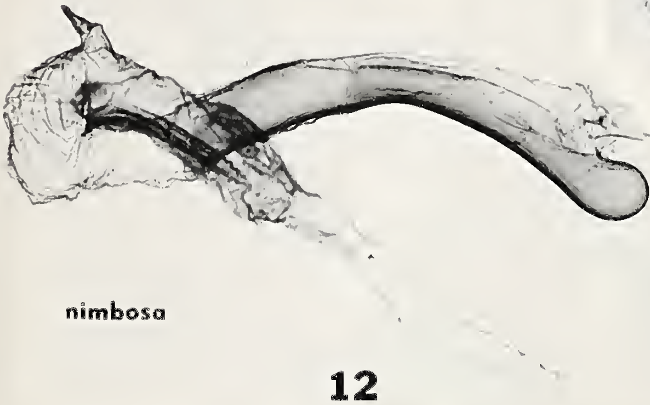
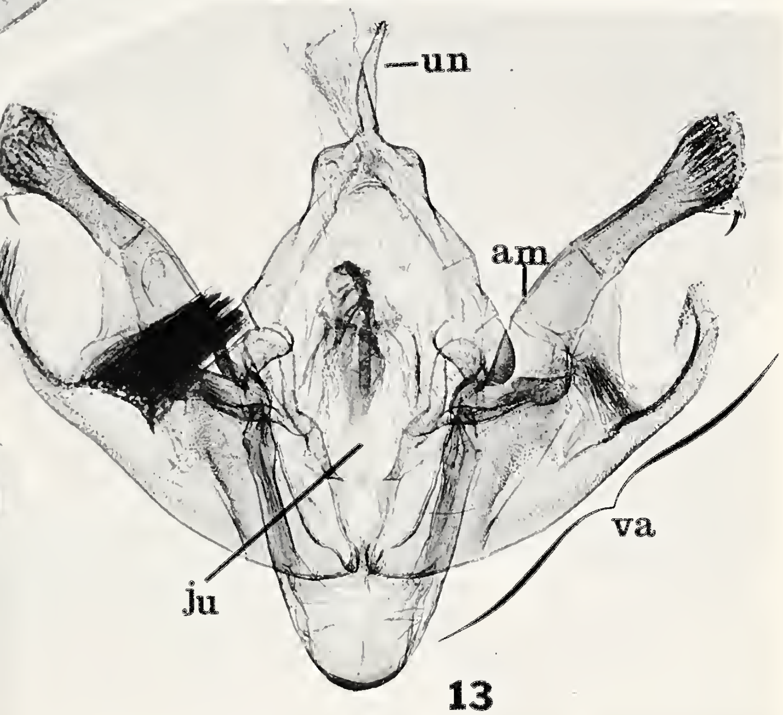


nimbosa

12



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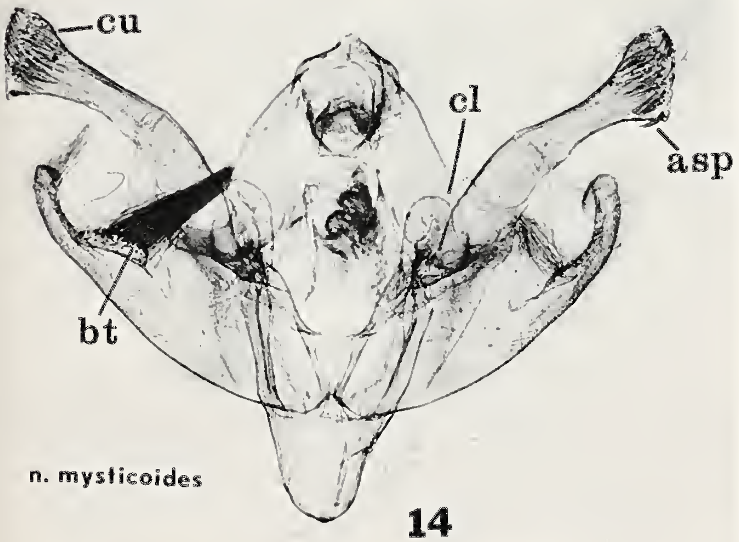
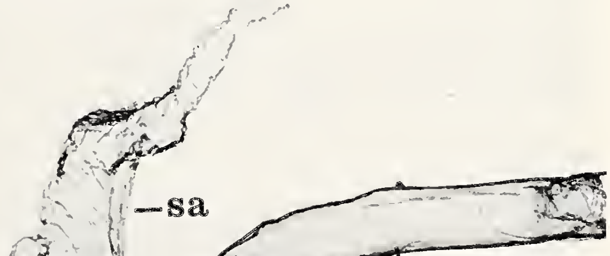


n. mysticoides

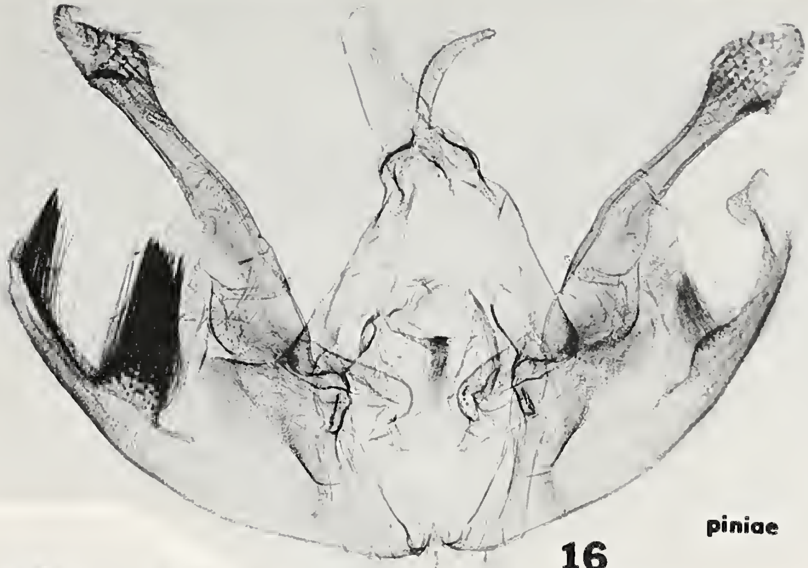
14



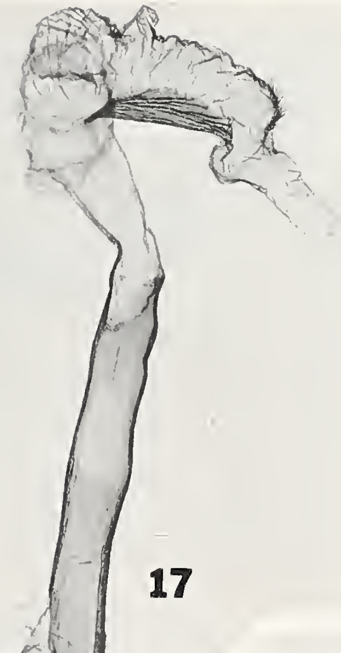
15

MALE GENITALIA

16 — *Polia piniae*, valves, Siskiyou Co., California, slide no. 112 [UCB].
17 — *Polia piniae*, aedeagus with vesica everted, same data [UCB].
18 — *Polia discalis*, aedeagus with vesica everted, Sweet Grass Co., Montana, slide no. 29 [JGF].
19 — *Polia discalis*, valves, same data [JGF].
20 — *Polia propodea*, HOLOTYPE, valves, Mt. Evans, Colorado, slide no. 260 [CNC].
21 — *Polia propodea*, HOLOTYPE, aedeagus with vesica everted, same data [CNC].



16 piniae



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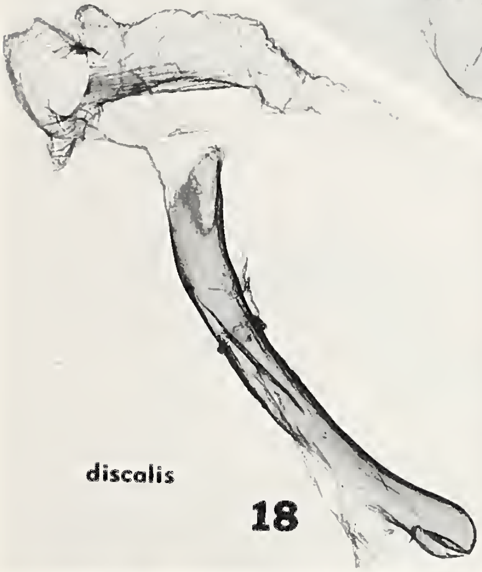
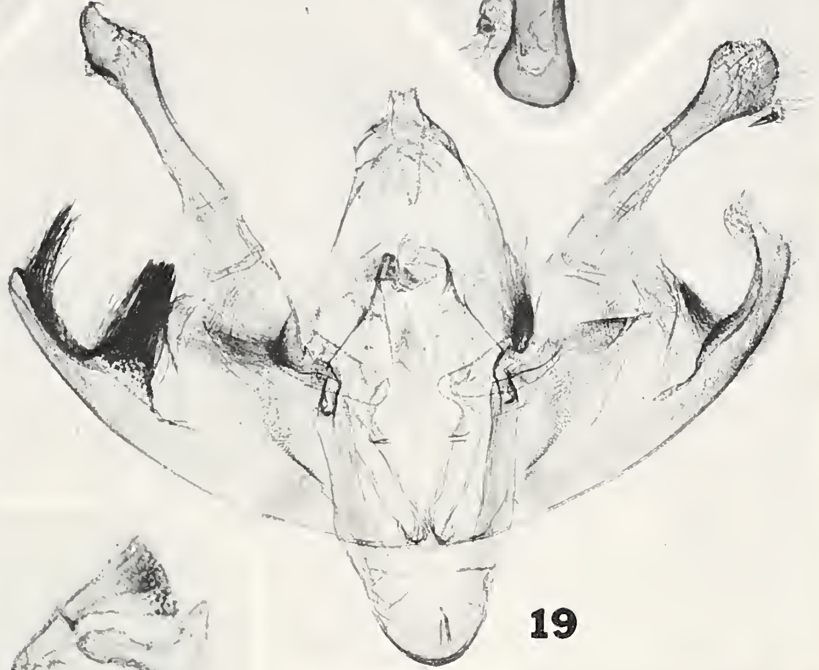


18 discalis



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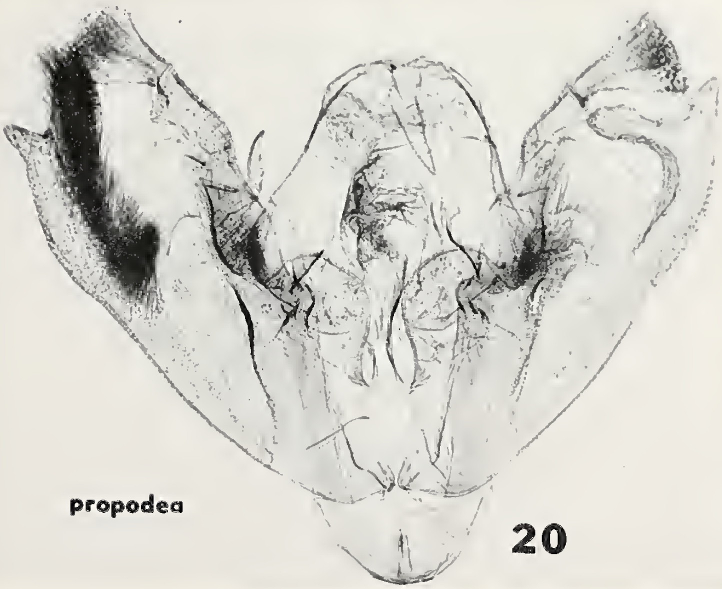
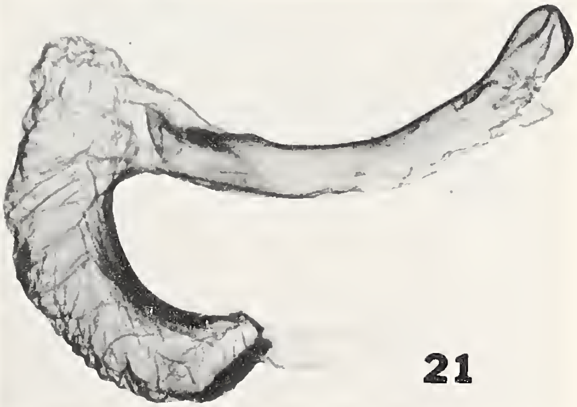


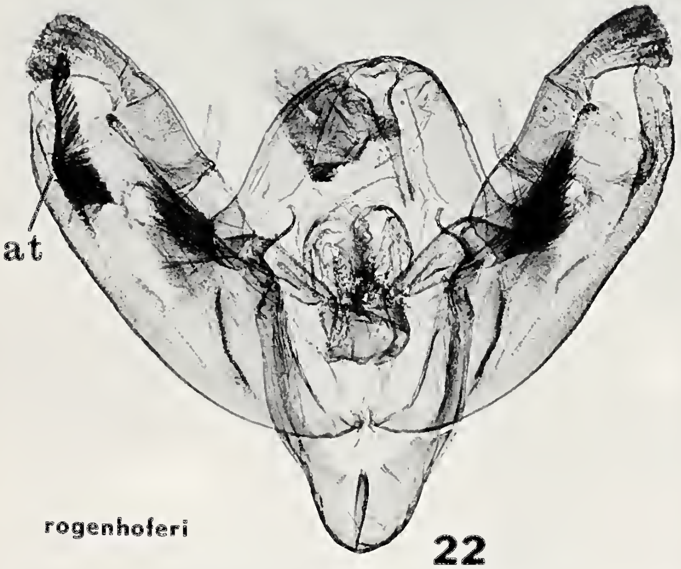
20 propodea



21

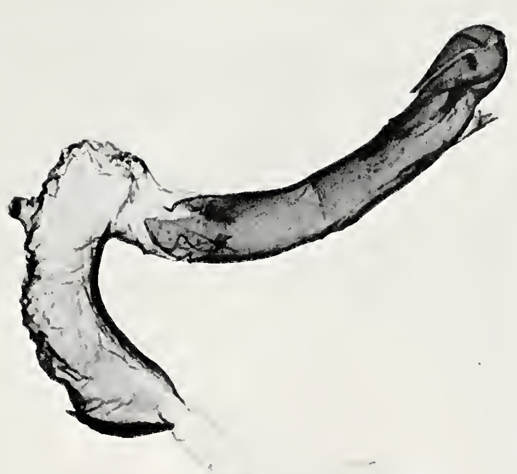
MALE GENITALIA

22 — *Polia rogenhoferi*, valves, Pitkin Co., Colorado, slide no. 237 [TLM].
at, apical tuft (of lower margin of valve).
23 — *Polia rogenhoferi*, aedeagus with vesica everted, same data [TLM].
24 — *Polia richardsoni*, aedeagus with vesica everted, collection Brooklyn Museum, slide no. 207 [USNM].
25 — *Polia richardsoni*, valves, same data [USNM].
26 — *Polia nugatis*, valves, Truckee, California, slide no. 13 [USNM].
27 — *Polia nugatis*, aedeagus with vesica everted, same data [USNM].



rogenhoferi

22



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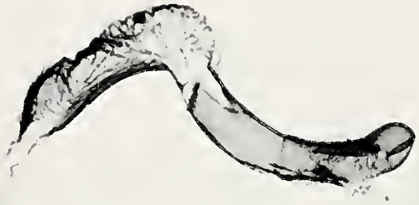
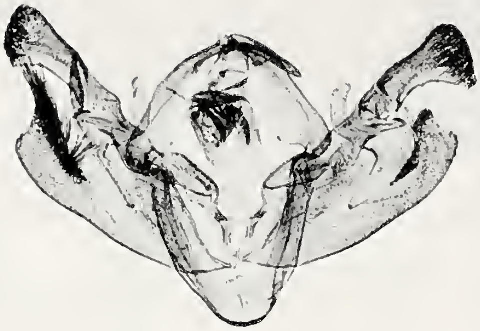


richardsoni

24



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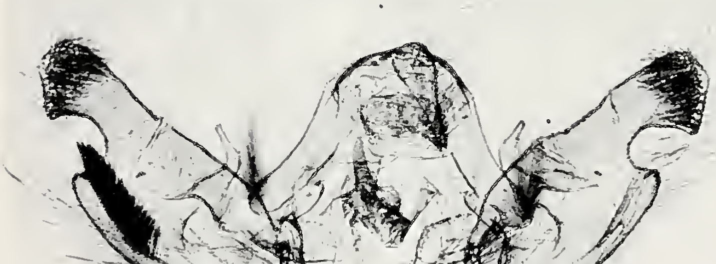
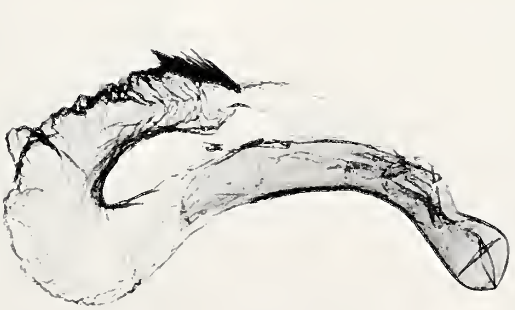


nugatis

26



27

MALE GENITALIA

28 — *Polia purpurissata*, valves, Clay Co., Minnesota, slide no. 262 [TLM].

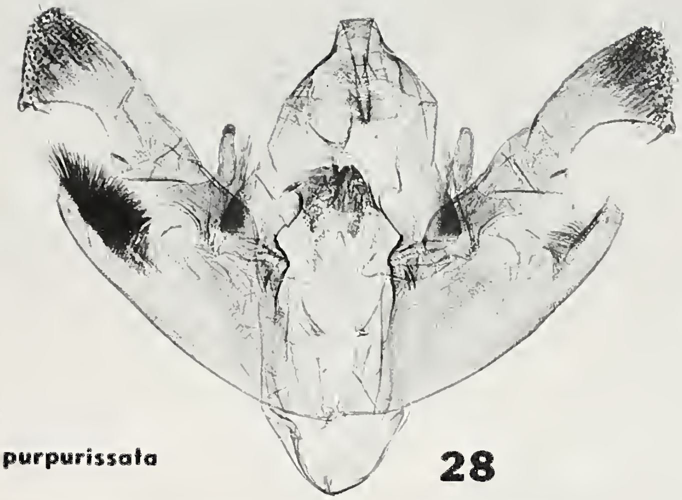
29 — *Polia purpurissata*, aedeagus with vesica everted, same data [TLM].

30 — *Polia purpurissata* subspecies *apurpura*, TYPE, aedeagus with vesica everted, White Mts., Arizona, USNM slide no. 1949 [USNM].

31 — *Polia purpurissata* subspecies *apurpura*, TYPE, valves, same data [USNM].

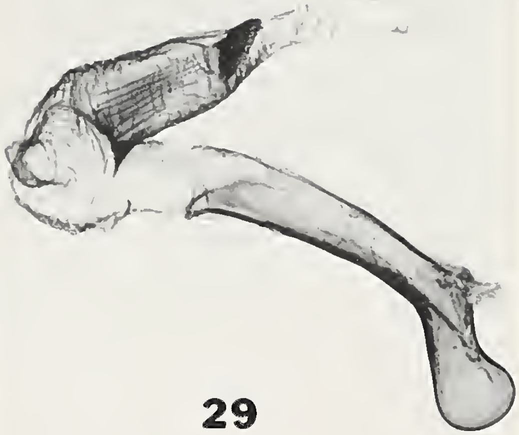
32 — *Polia purpurissata*, "languida" TYPE, valves, Colorado, USNM slide no. 1837 [USNM].

33 — *Polia purpurissata*, "languida" TYPE, aedeagus with vesica everted, same data [USNM].



purpurissata

28



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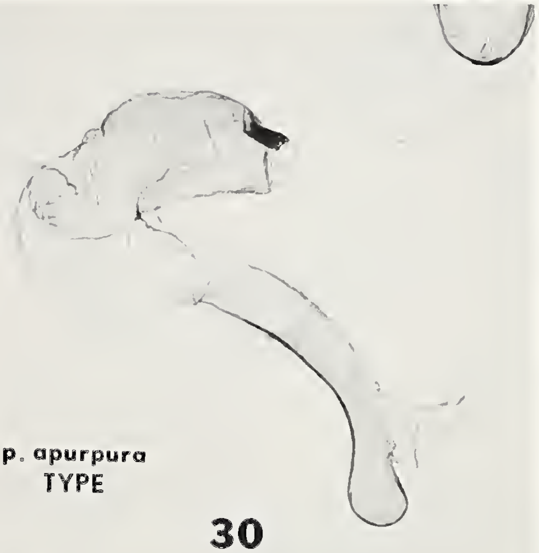
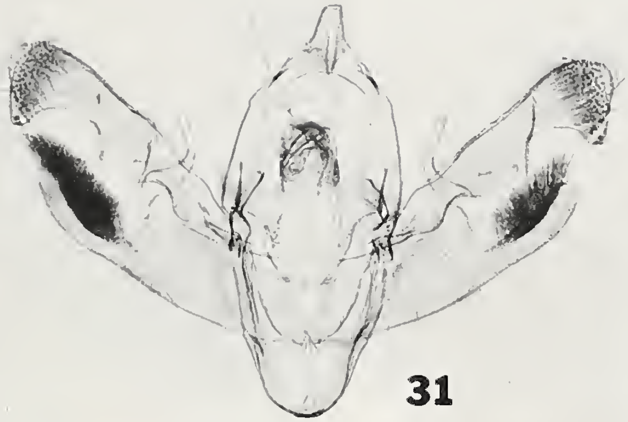


p. apurpura
TYPE

30



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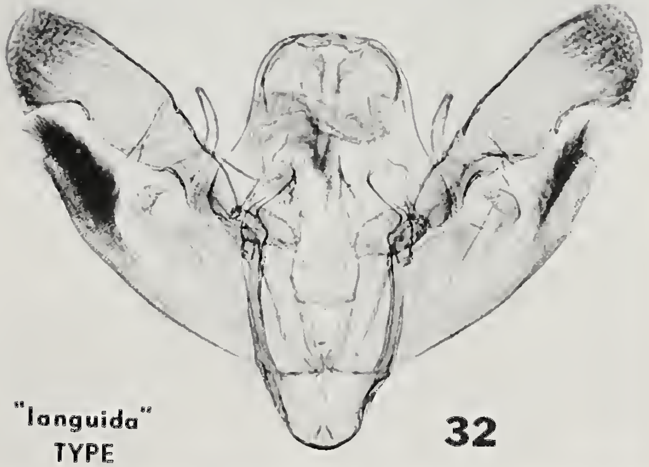
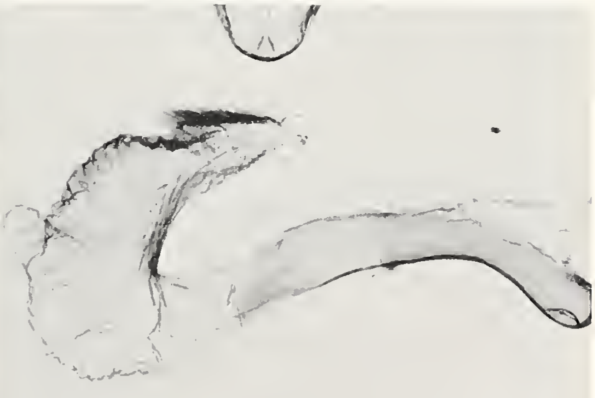


"languida"
TYPE

32



33

MALE GENITALIA

34 — *Melanchra adjuncta*, valves, Idaho Co., Idaho, slide no. 219 [TLM].
ssc, subscaphium.

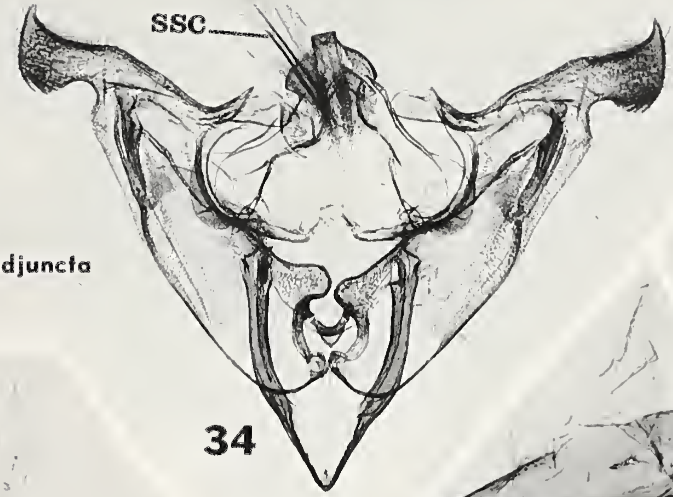
35 — *Melanchra adjuncta*, aedeagus with vesica everted, same data [TLM].
as, aedeagal spur.

36 — *Melanchra picta*, aedeagus with vesica everted, Slope Co., North Dakota, slide no. 225 [TLM].

37 — *Melanchra picta*, valves, same data [TLM].
co, costa; cp, costal process.

38 — *Melanchra pulverulenta*, valves, Essex Co., Vermont, slide no. 66 [TLM].

39 — *Melanchra pulverulenta*, aedeagus with vesica everted, same data [TLM].



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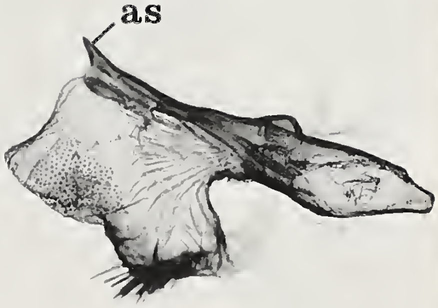

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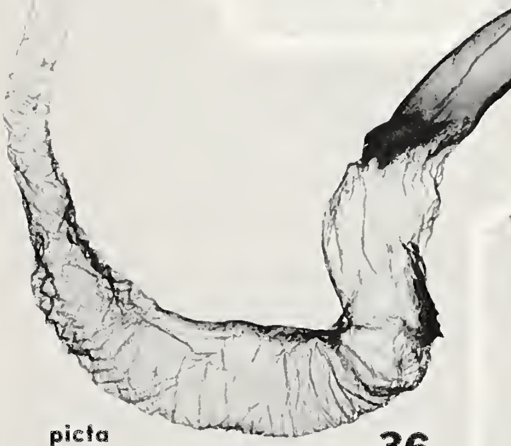

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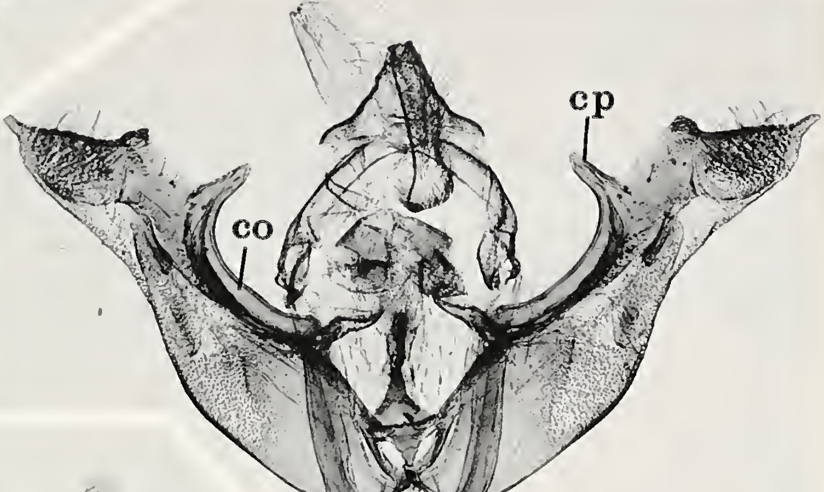

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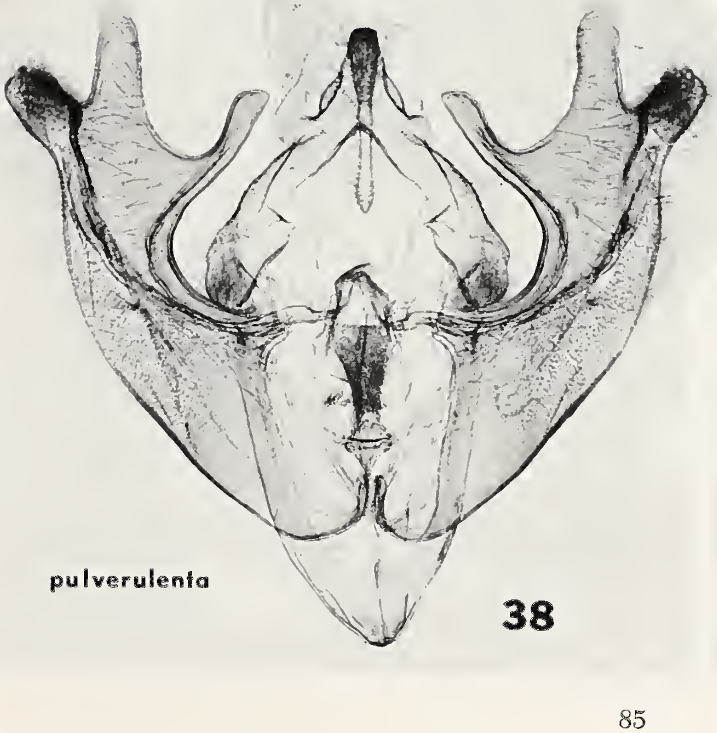

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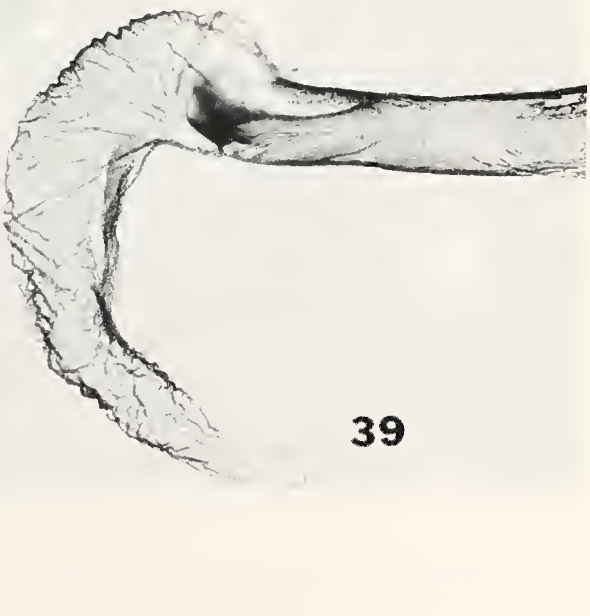


39

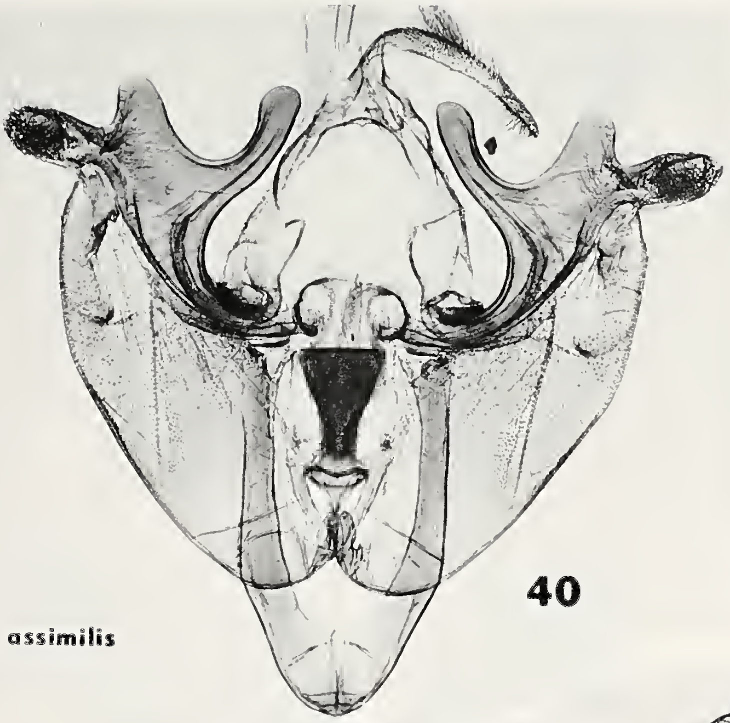
MALE GENITALIA

40 — *Melanchra assimilis*, valves, Baddeck, Nova Scotia, slide no. 162 [CNC].

41 — *Melanchra assimilis*, aedeagus with vesica everted, same data [CNC].

42 — *Spiramater lutra*, aedeagus with vesica everted, Chenango Co., New York, slide no. 231 [TLM]. bc, bulbed cornutus.

43 — *Spiramater lutra*, valves, same data [TLM].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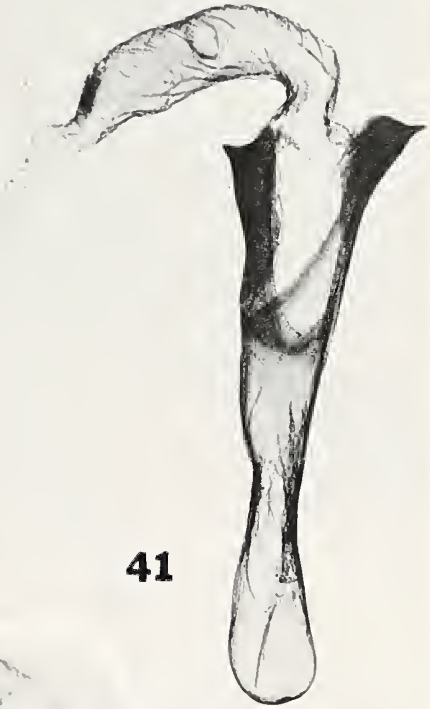
assimilis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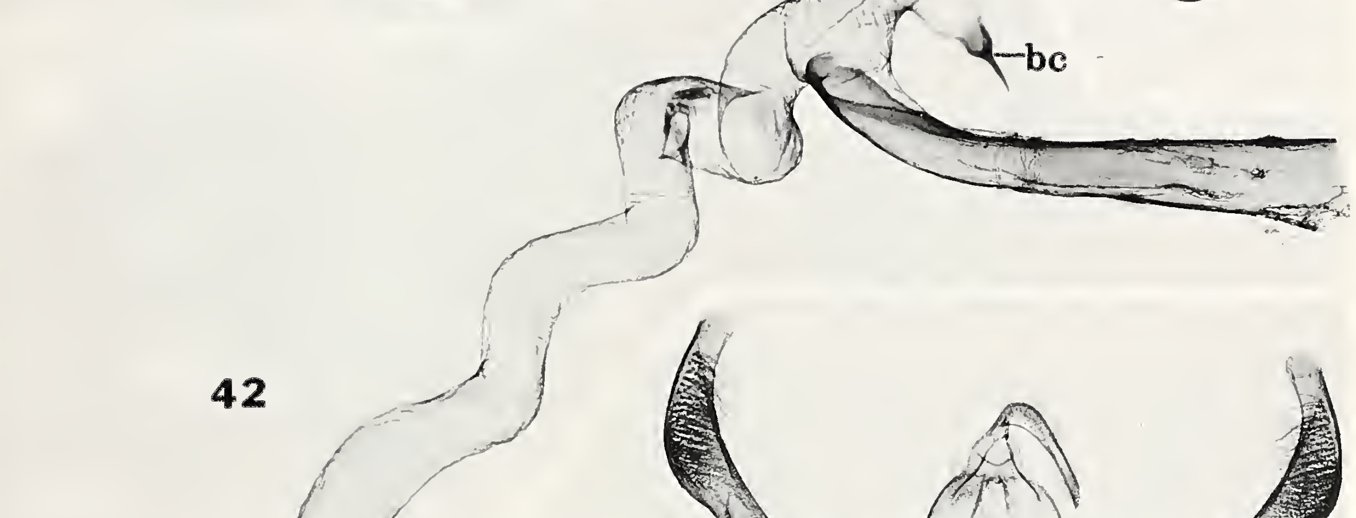

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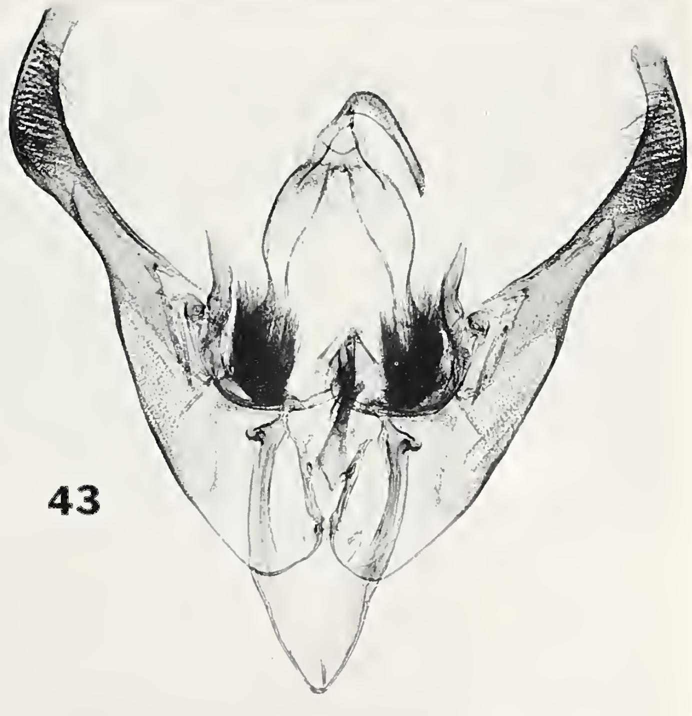
lutra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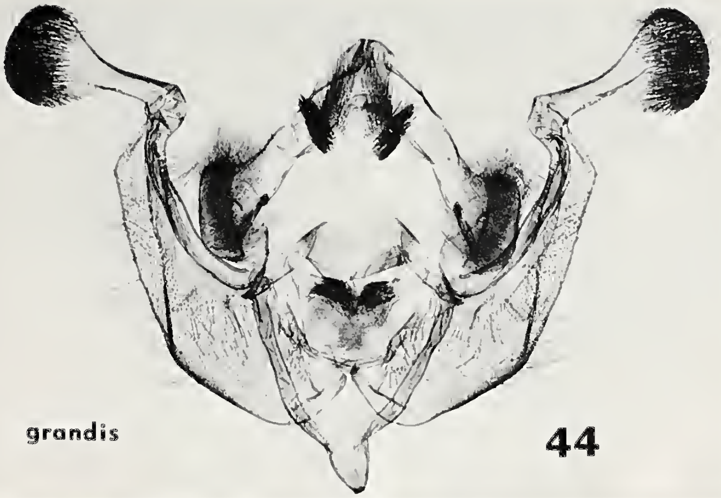
MALE GENITALIA

44 — *Spiramater grandis*, valves, Essex Co., Vermont, slide no. 65 [TLM].
45 — *Spiramater grandis*, aedeagus with vesica everted, same data [TLM].
46 — *Lacanobia subjuncta*, valves, Idaho Co., Idaho, slide no. 226 [TLM].
47 — *Lacanobia subjuncta*, aedeagus with vesica everted, same data [TLM].
48 — *Lacanobia nevadae*, aedeagus with vesica everted, Linn Co., Oregon, slide no. 174 [TLM].
49 — *Lacanobia nevadae*, valves, same data [TLM].



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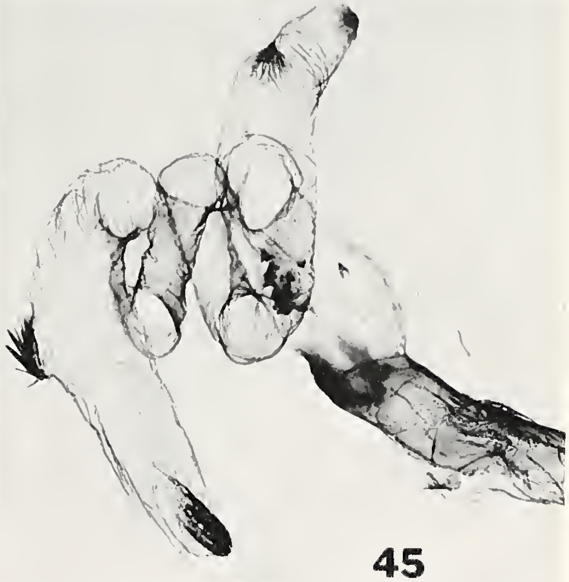

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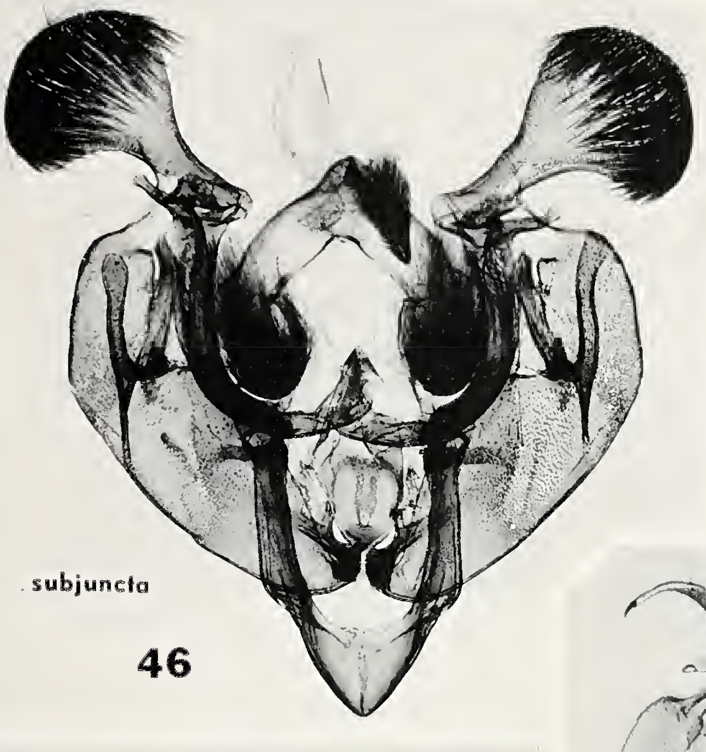

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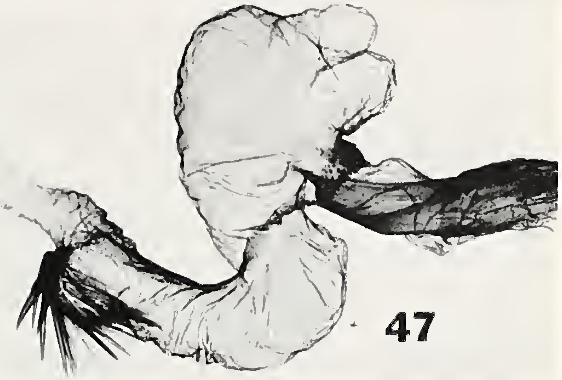

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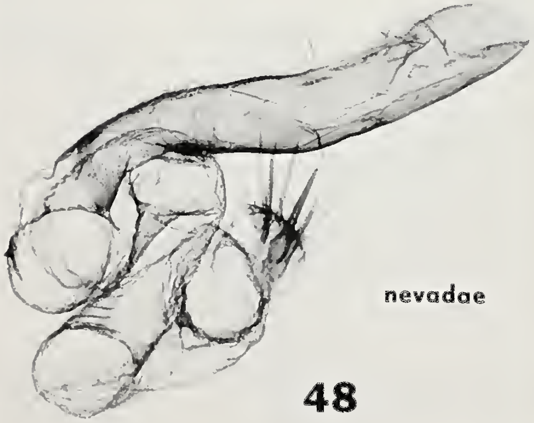

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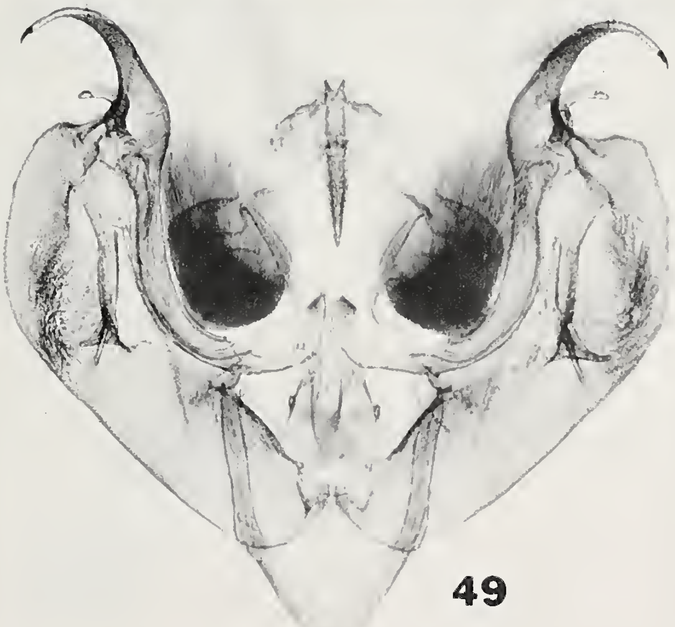

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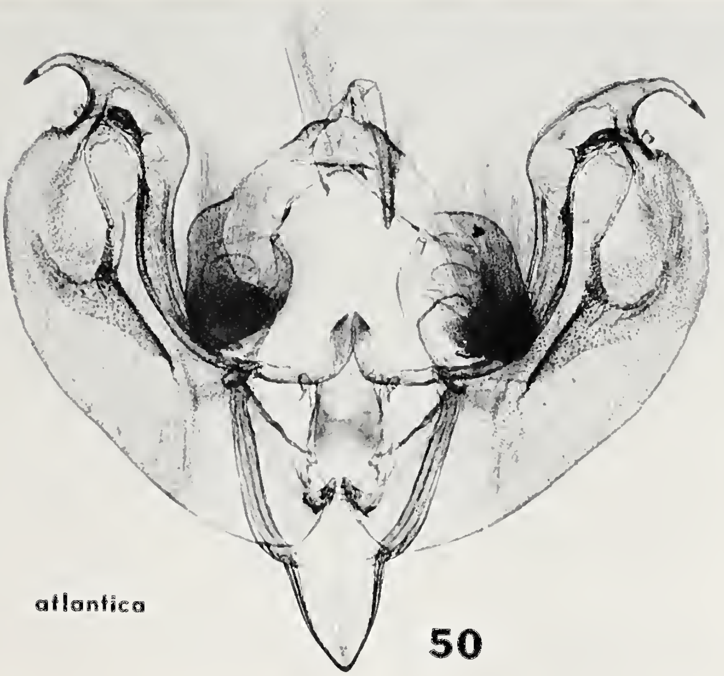
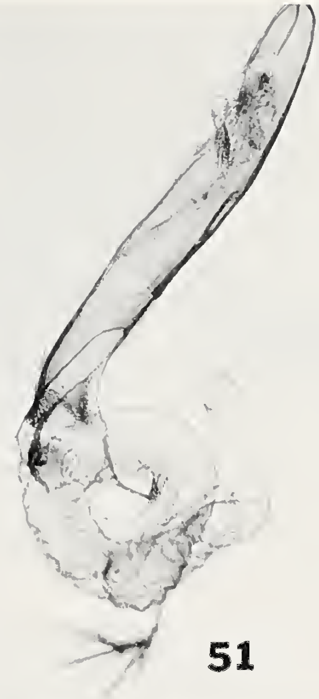
MALE GENITALIA

50 — *Lacanobia atlantica*, valves, Pembina Co., North Dakota, slide no. 75 [TLM].
51 — *Lacanobia atlantica*, aedeagus with vesica everted, same data [TLM].
52 — *Lacanobia radix*, aedeagus with vesica everted, Bottineau Co., North Dakota, slide no. 263 [TLM].
53 — *Lacanobia radix*, valves, same data [TLM].
54 — *Trichordestra rugosa*, valves, Sudbury, Ontario, slide no. 17 [USNM].
55 — *Trichordestra rugosa*, aedeagus with vesica everted, same data [USNM].



atlantica

50



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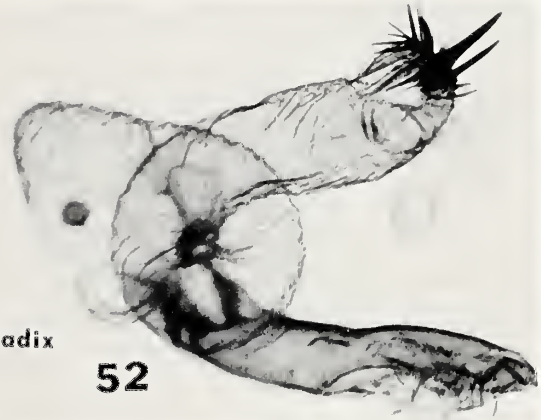

radix

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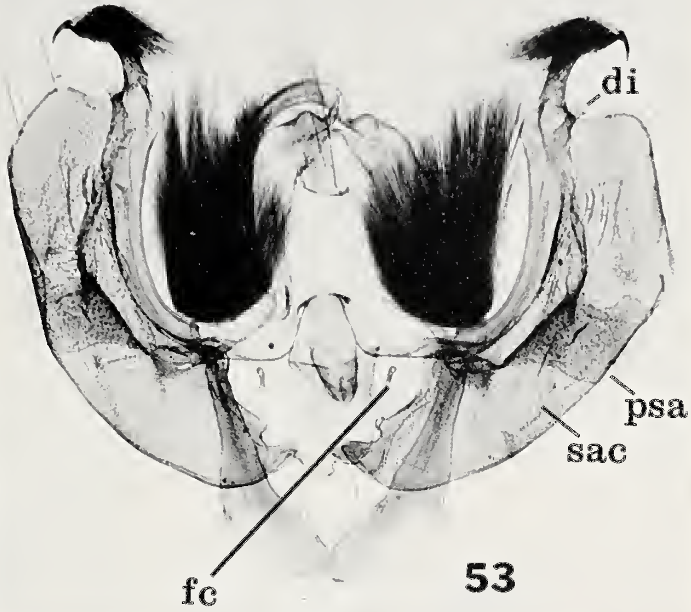

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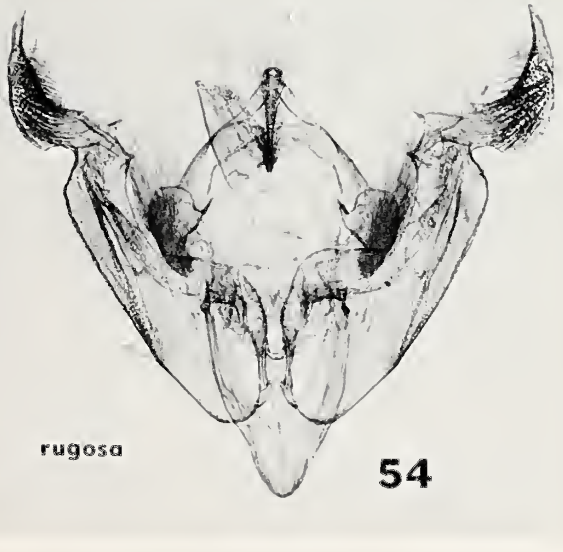
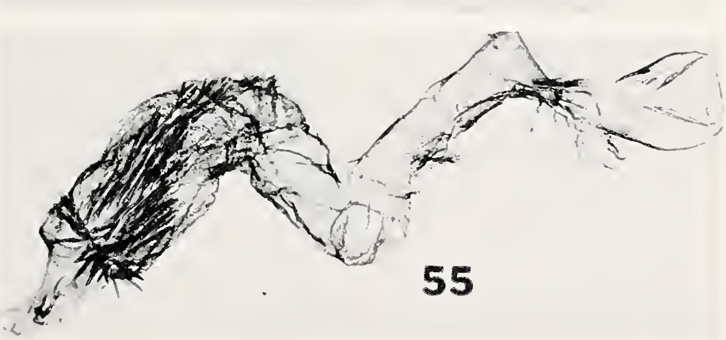


rugosa

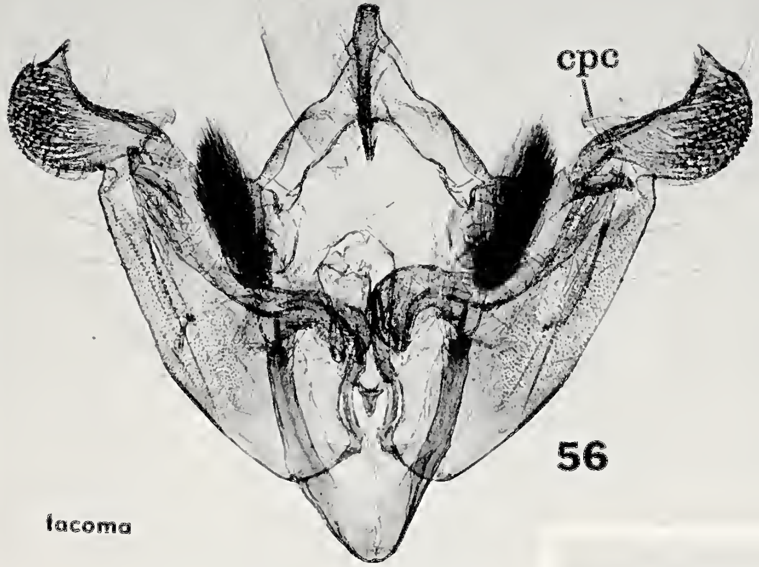
54



55

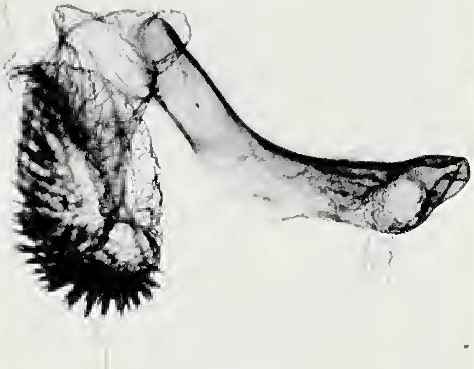
MALE GENITALIA

56 — *Trichordestra tacoma*, valves, Clay Co., Minnesota, slide no. 198. [TLM].
cpc, costal process of cucullus.
57 — *Trichordestra tacoma*, aedeagus with vesica everted, same data [TLM].
58 — *Trichordestra legitima*, aedeagus with vesica everted, Albany Co., New York, slide no. 98 [TLM].
59 — *Trichordestra legitima*, valves, same data [TLM].
60 — *Trichordestra dodii*, valves, Longs Peak Inn, Colorado, slide no. 127 [USNM].
61 — *Trichordestra dodii*, aedeagus with vesica everted, same data [USNM].



56

tacoma



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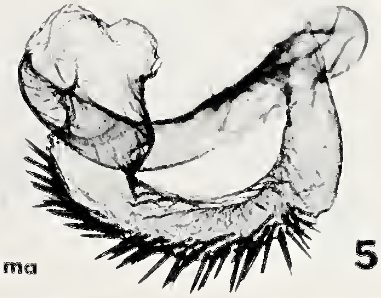
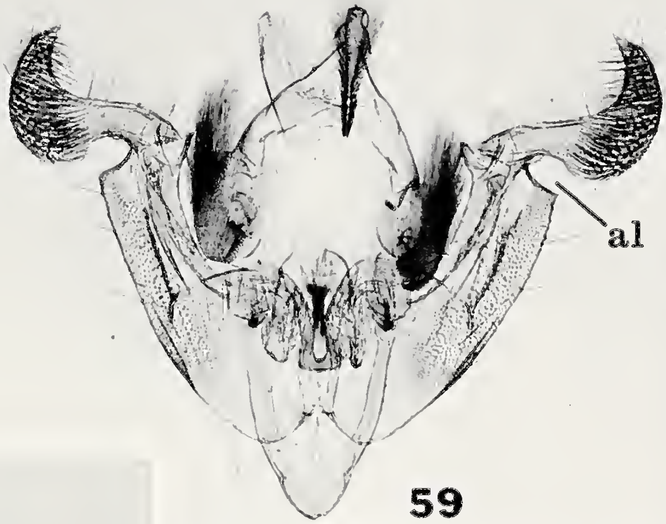


58

legitima



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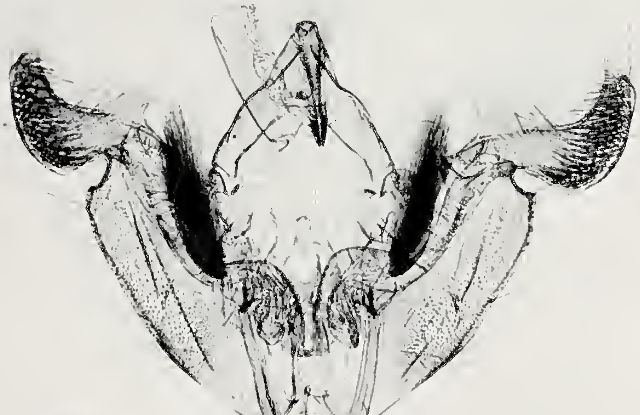
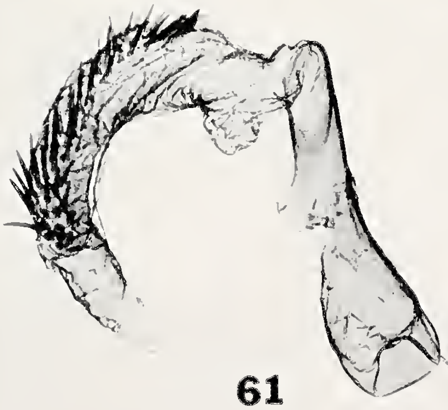


60

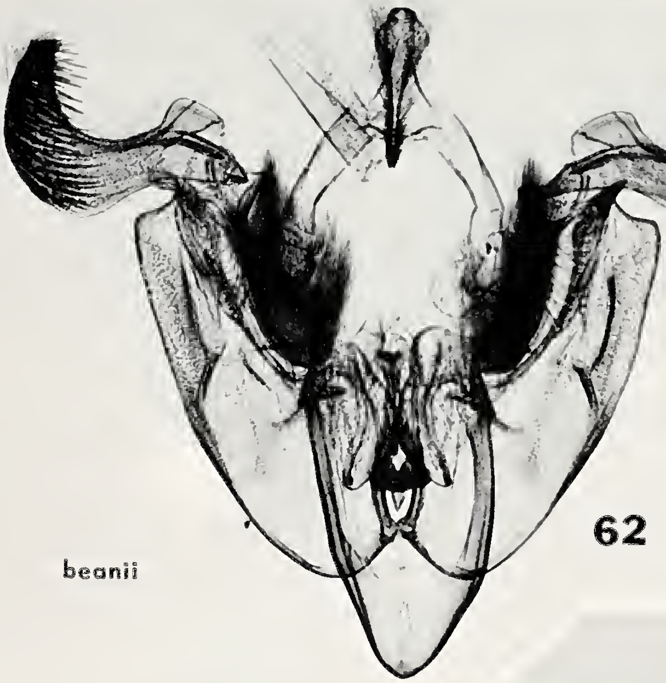
dodii



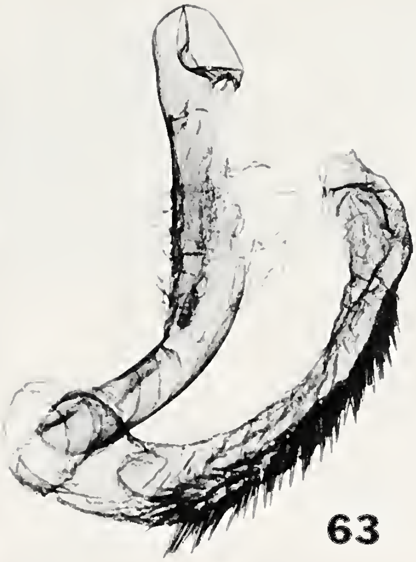
61

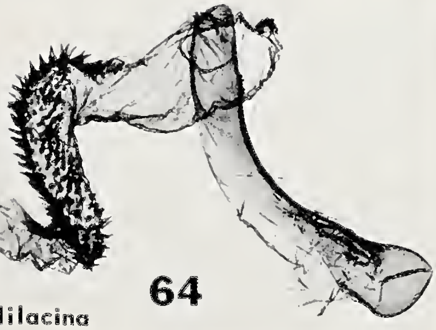
MALE GENITALIA

62 — *Trichordestra beanii*, valves, Highlands, North Carolina, slide no. 141 [CNC].
63 — *Trichordestra beanii*, aedeagus with vesica everted, same data [CNC].
64 — *Trichordestra lilacina*, aedeagus with vesica everted, Coconino Co., Arizona, slide no. 81 [JGF].
65 — *Trichordestra lilacina*, valves, Slope Co., North Dakota, slide no. 162 [TLM].
66 — *Trichordestra liquida*, valves, Wallace, Idaho, slide no. 110 [USNM].
67 — *Trichordestra liquida*, aedeagus with vesica everted, same data [USNM].

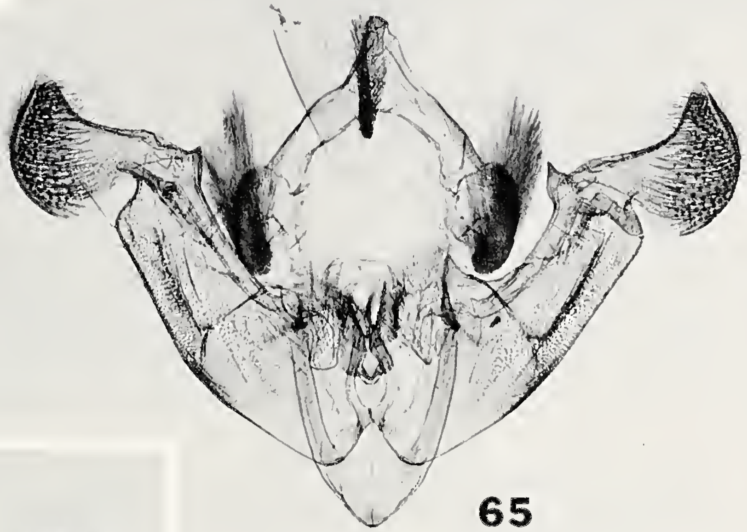

62

beanii


63


64

lilacina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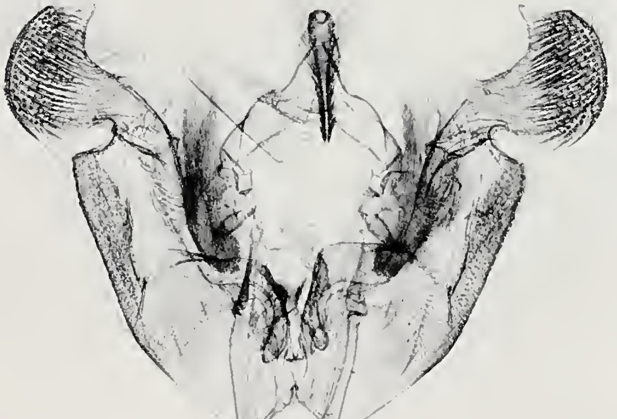
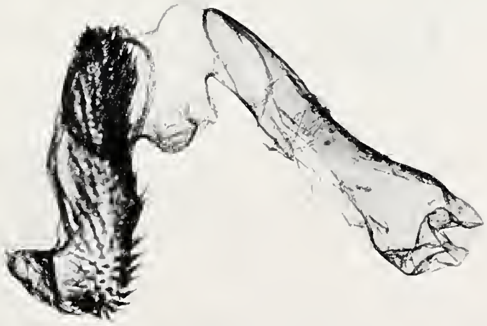
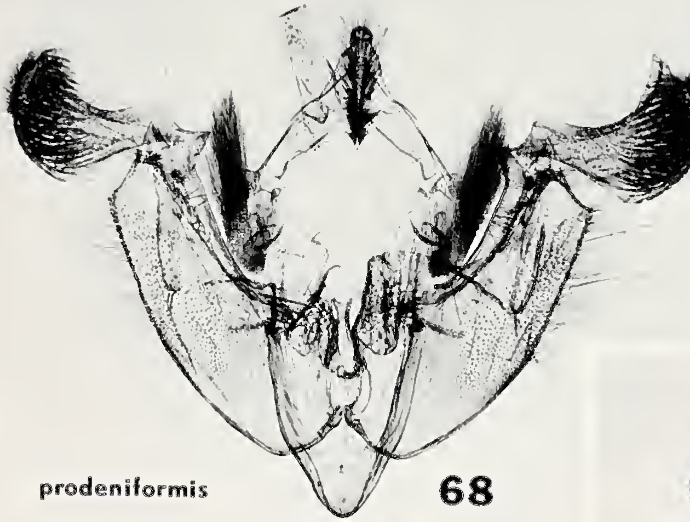

66

liquida


67

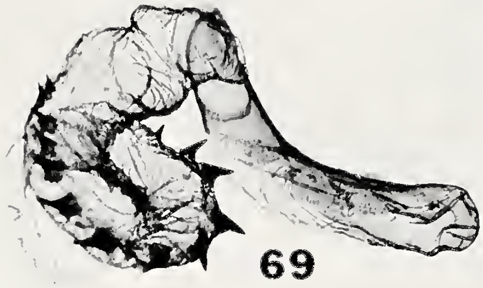
MALE GENITALIA

68 — *Trichordestra prodeniformis*, valves, Cochise Co., Arizona, slide no. 56 [TLM].
69 — *Trichordestra prodeniformis*, aedeagus with vesica everted, same data [TLM].
70 — *Papestra quadrata*, TYPE, aedeagus with vesica everted, Placer Co., California, USNM slide no. 1964 [USNM].
71 — *Papestra quadrata*, TYPE, valves, same data [USNM].
72 — *Papestra quadrata*, valves, Kenai Peninsula, Alaska, slide no. 235 [CNC].
pc, process of costa.
73 — *Papestra quadrata*, aedeagus with vesica everted, same data [CNC].

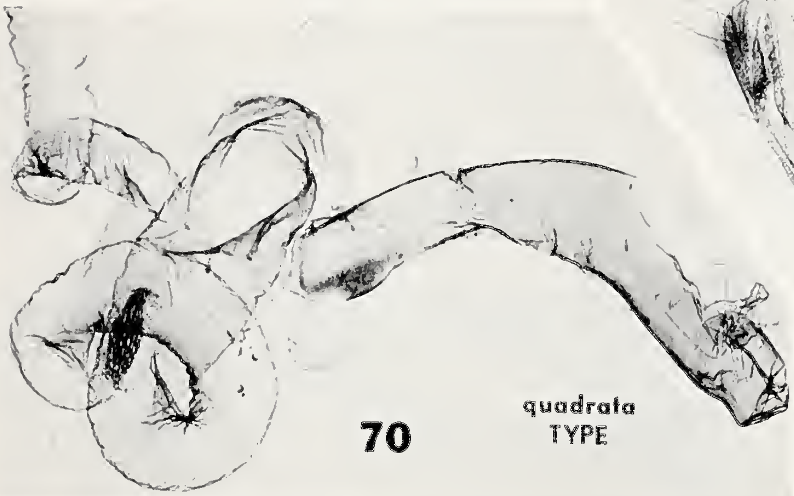


prodeniformis

68

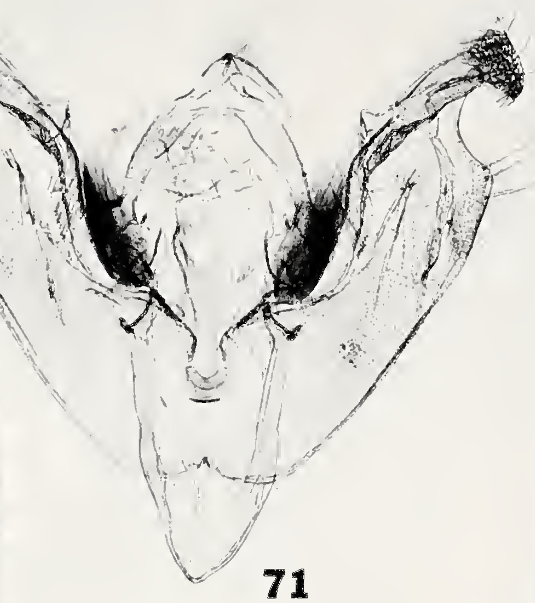


69

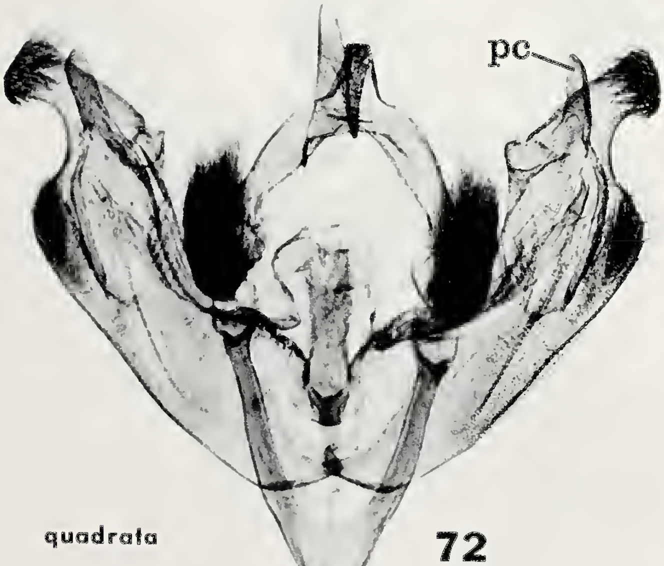


70

quadrata
TYPE

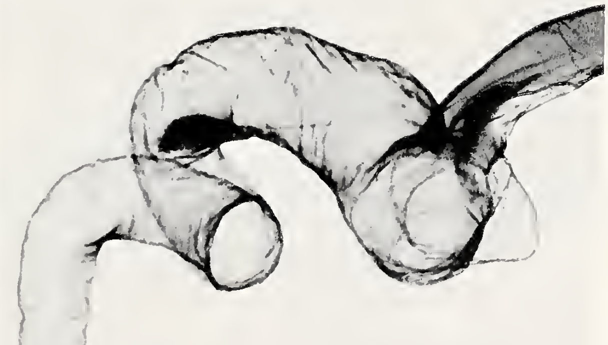


71



quadrata

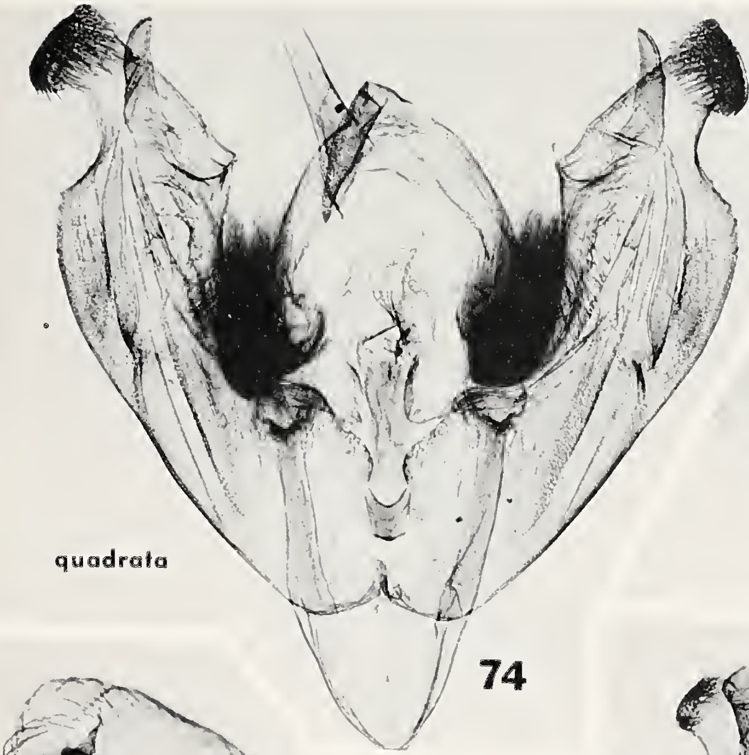
72



73

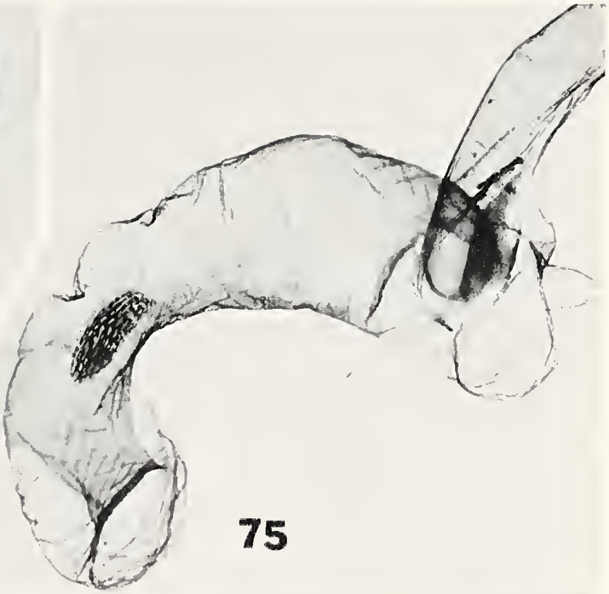
MALE GENITALIA

74 — *Papestra quadrata*, valves, Halifax Co., Nova Scotia, slide no. 265 [JGF].
75 — *Papestra quadrata*, aedeagus with vesica everted, same data [JGF].
76 — *Papestra biren*, aedeagus with vesica everted, Halifax Co., Nova Scotia, slide no. 130 [CNC].
77 — *Papestra biren*, valves, same data [CNC].
78 — *Papestra cristifera*, valves, Idaho Co., Idaho, slide no. 236 [TLM].
79 — *Papestra cristifera*, aedeagus with vesica everted, same data [TLM].

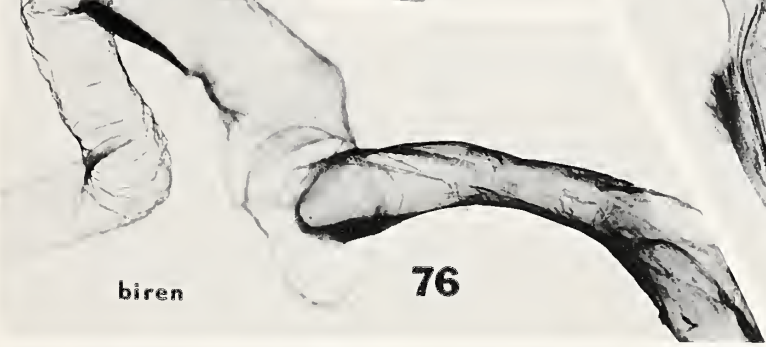


quadrata

74

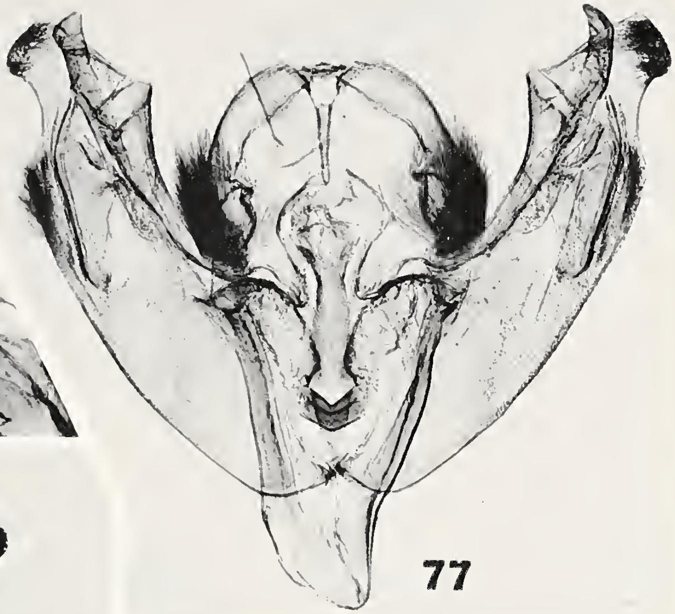


75

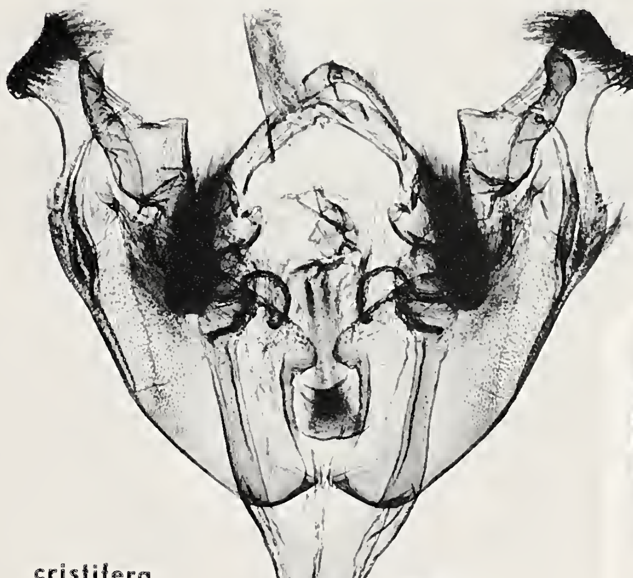


biren

76

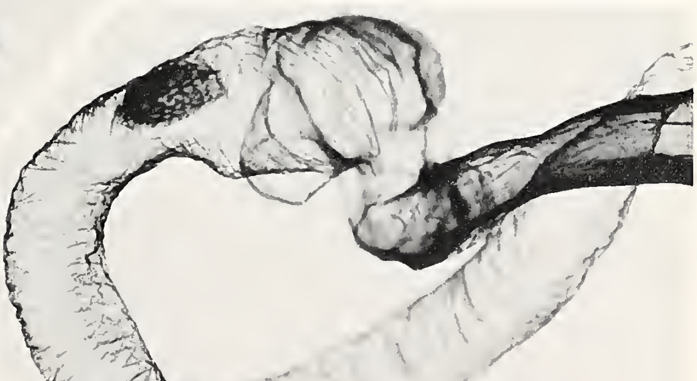


77



cristifera

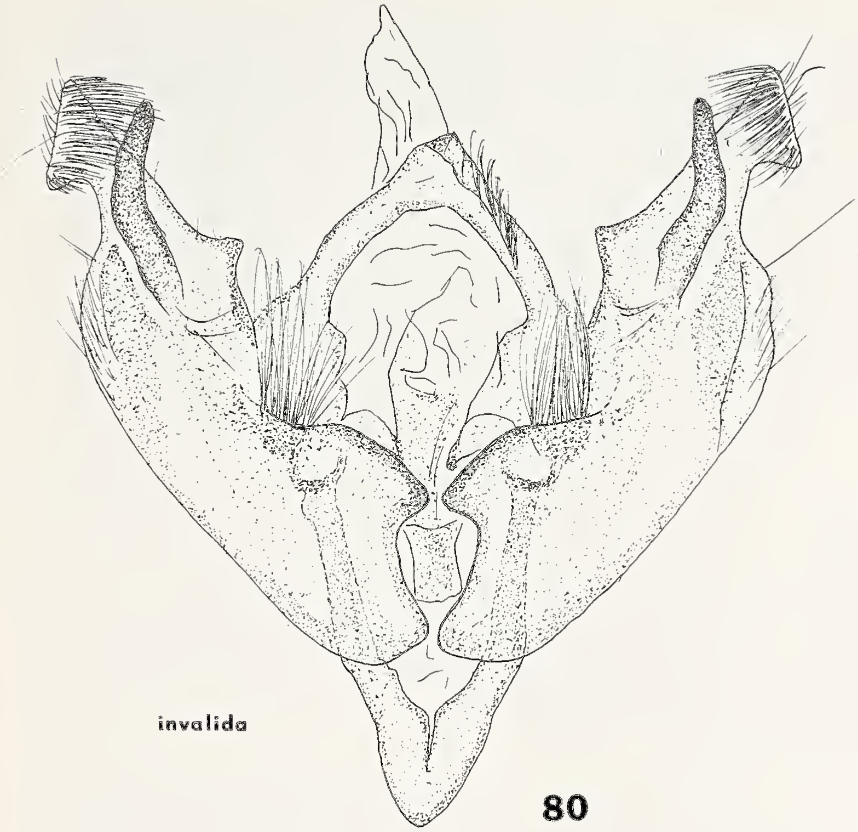
78



79

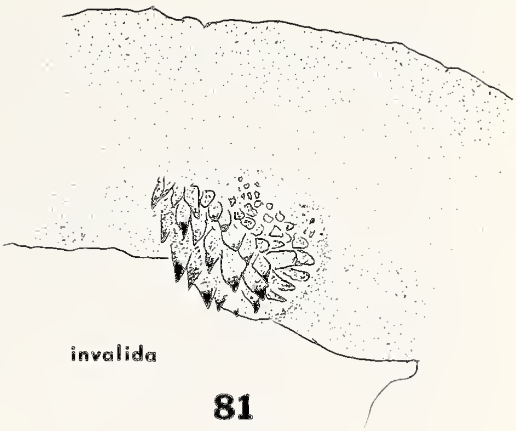
MALE GENITALIA

80 — *Papestra invalida*, valves, Johnsville, California, slide no. 287 [DAVIS].
81 — *Papestra invalida*, cornuti, same data [DAVIS].
82 — *Papestra cristifera*, cornuti, Idaho Co., Idaho, slide no. 236 [TLM].
83 — *Papestra brenda*, valves, Elko Co., Nevada, slide no. 293 [USNM].
84 — *Papestra cristifera*, valves, Idaho, Co., Idaho, slide no. 197 [TLM].



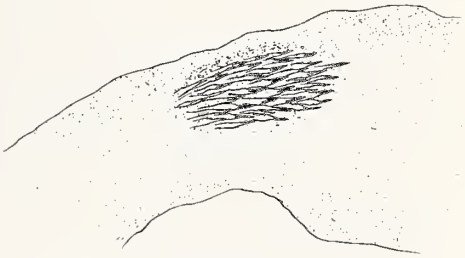
invalida

80



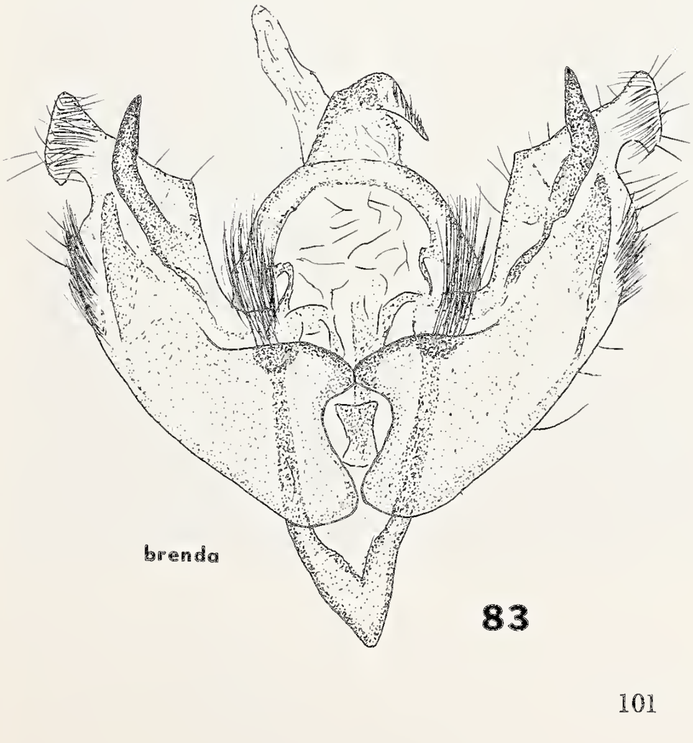
invalida

81



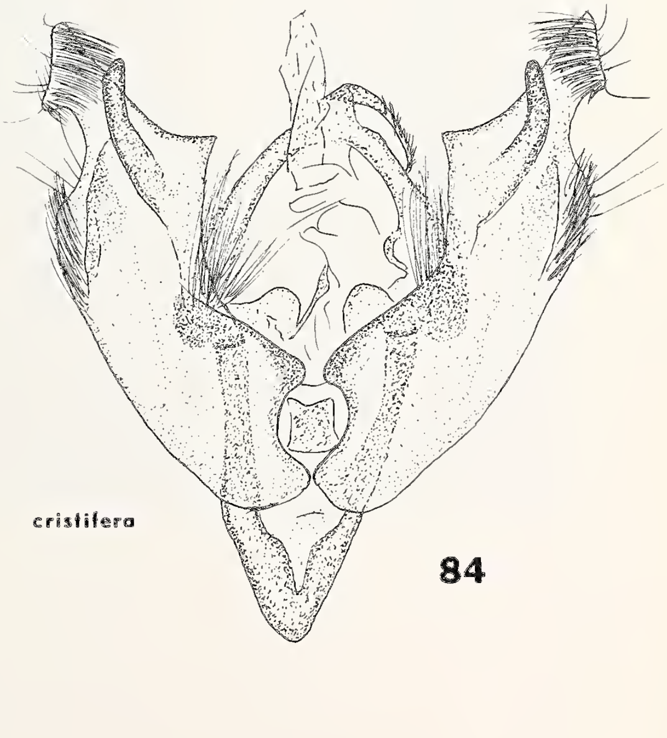
cristifera

82



brenda

83

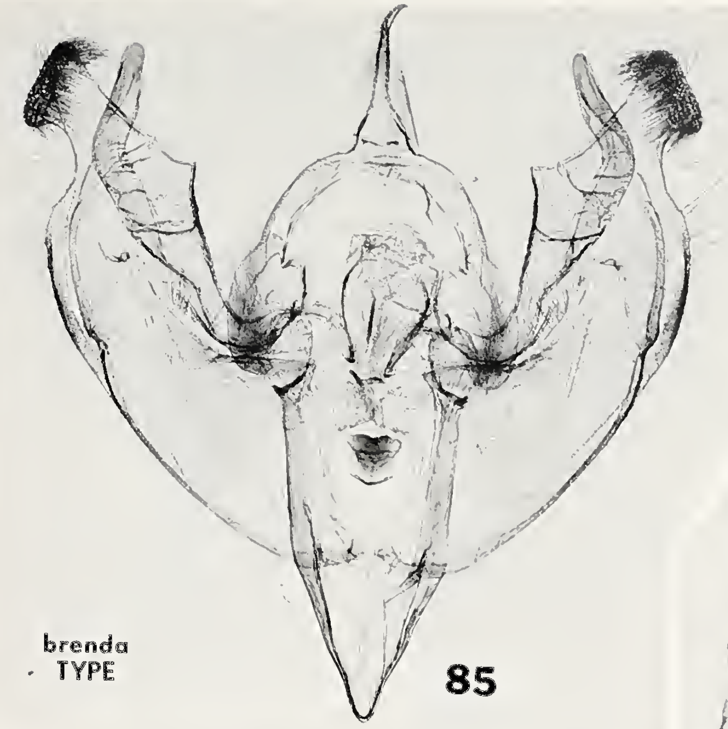


cristifera

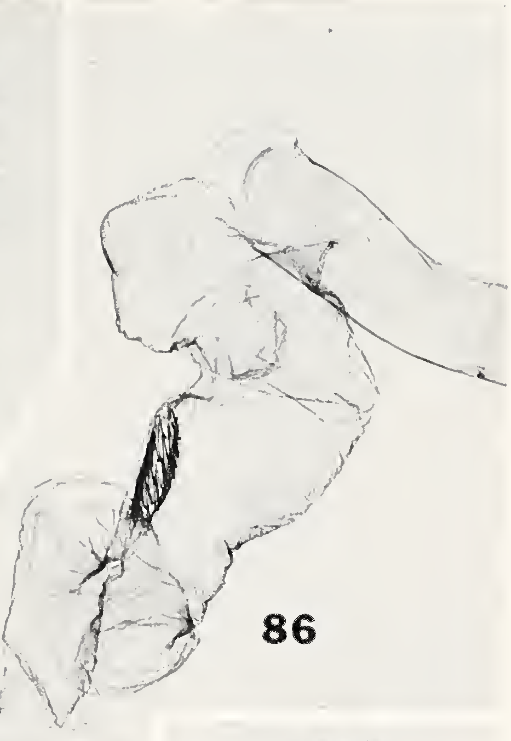
84

MALE AND FEMALE GENITALIA

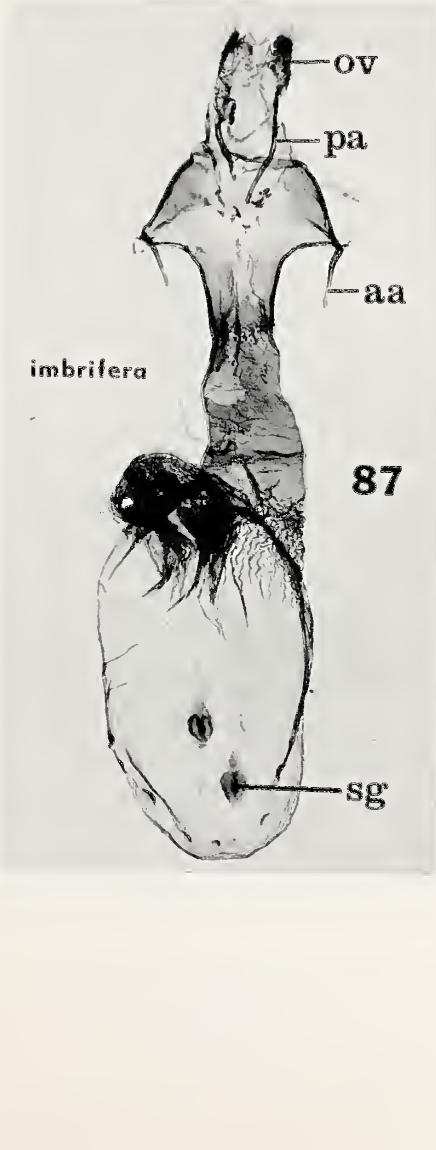
85 — *Papestra brenda*,TYPE, valves, Stockton, Utah, USNM slide no. 1962 [USNM].
86 — *Papestra brenda*, TYPE, aedeagus with vesica everted, same data [USNM].
87 — *Polia imbrifera*, Albany Co., New York, slide no. 122 [TLM].
aa, anterior apophysis; pa, posterior apophysis;
ov, ovipositor valves; sg, signum.
88 — *Polia nimbosa*, Albany Co., New York, slide no. 55 [TLM].
b, bursa (bursa copulatrix); db, ductus bursa;
ds, ductus seminalis.
89 — *Polia piniae*, Glenn Co., California, slide no. 113 [UCB].
apx, appendix (appendix bursa); bb, band-like signa.


brenda
TYPE

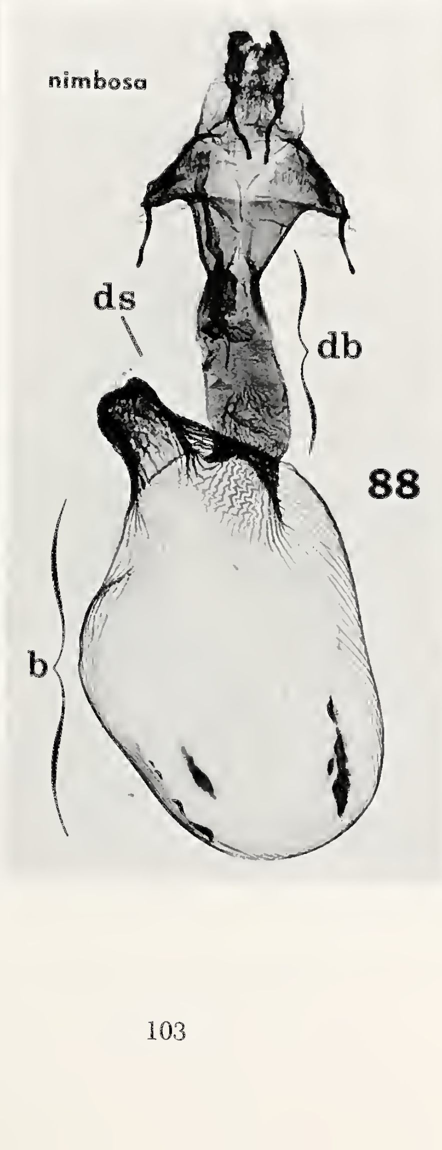
85



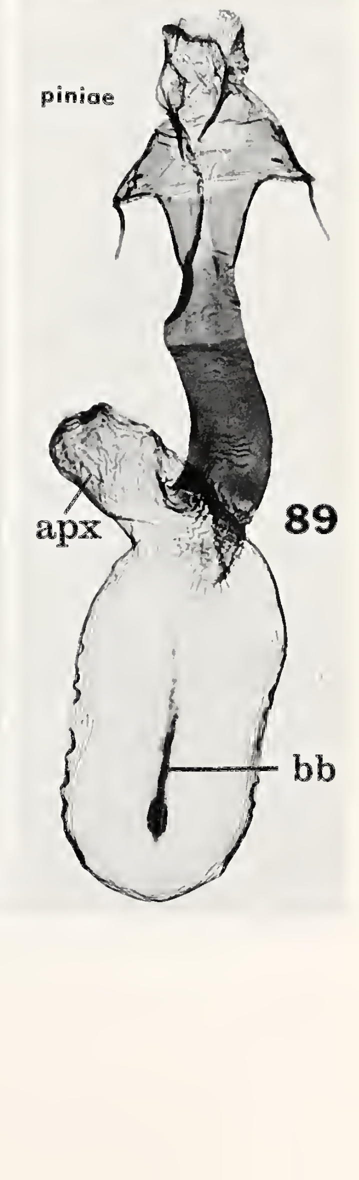
86


ov
pa
aa
imbrifera
sg

87


nimbosa
ds
db
b

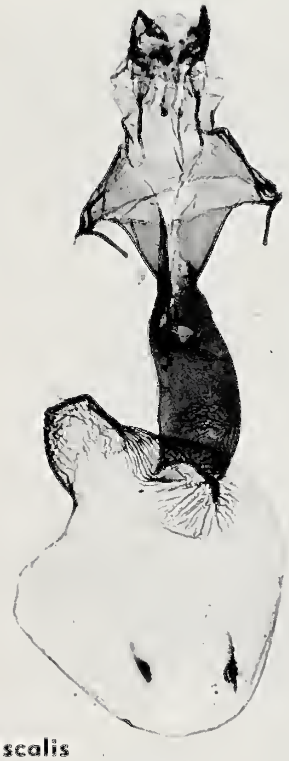
88


piniae
apx
bb

89

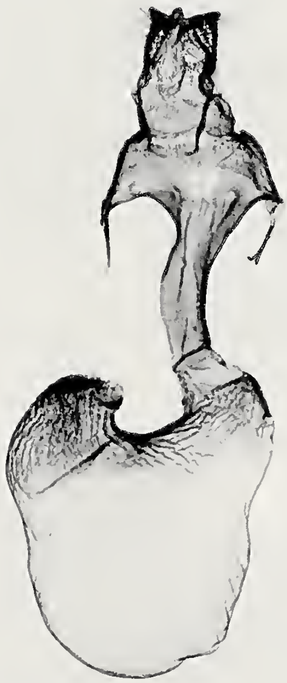
FEMALE GENITALIA

90 — *Polia discalis*, McKenzie Co., North Dakota, slide no. 86 [TLM].
91 — *Polia propodea*, Echo Lake, Colorado, slide no. 134 [CNC].
92 — *Polia rogenhoferi*, Lake Louise, Alberta, slide no. 144 [CNC].
93 — *Polia richardsoni*, Umanak, Greenland, slide no. 248 [USNM].
94 — *Polia nugatis*, Green River, Colorado, slide no. 238 [TLM].
95 — *Polia purpurissata*, Richland Co., North Dakota, slide no. 264 [TLM].



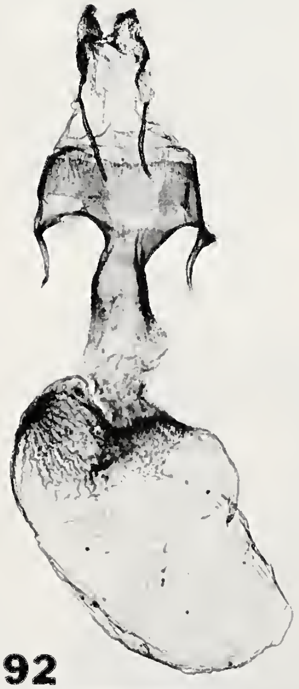
discalis

90



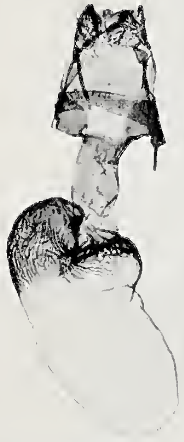
propodea

91



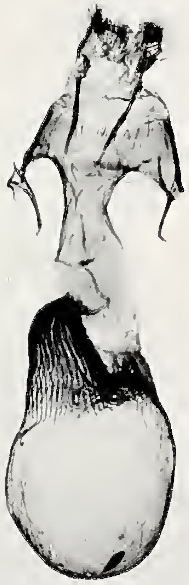
92

rogenhoferi



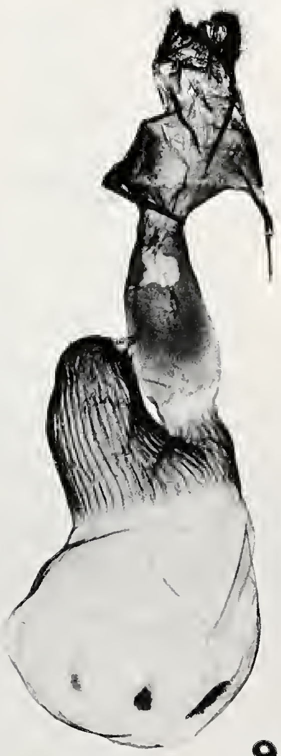
richardsoni

93



nugatis

94

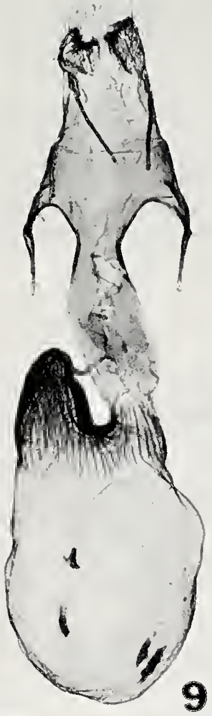


purpurissata

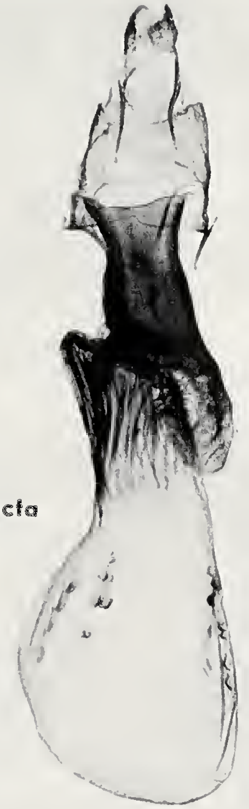
95

FEMALE GENITALIA

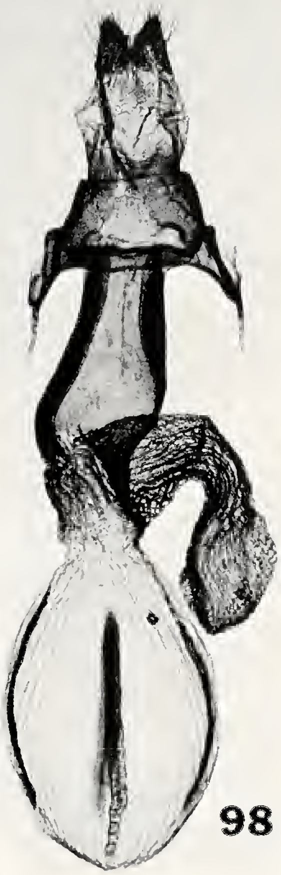
96 — *Polia purpurissata* subspecies *apurpura*, Coconino Co., Arizona, slide no. 277 [JGF].
97 — *Melanchra adjuncta*, Clay Co., Minnesota, slide no. 85 [TLM].
98 — *Melanchra picta*, Slope Co., North Dakota, slide no. 224 [TLM].
99 — *Melanchra pulverulenta*, Enfield, Maine, slide no. 232 [TLM].
100 — *Melanchra assimilis*, Orono, Maine, slide no. 108 [USNM].



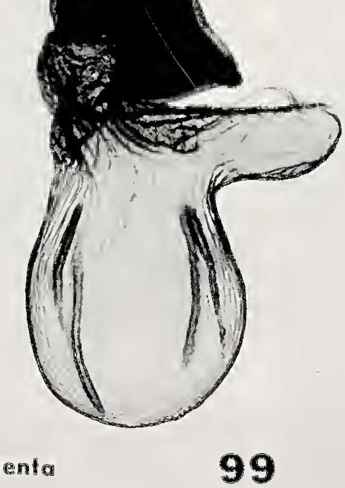
96 p. apurpura



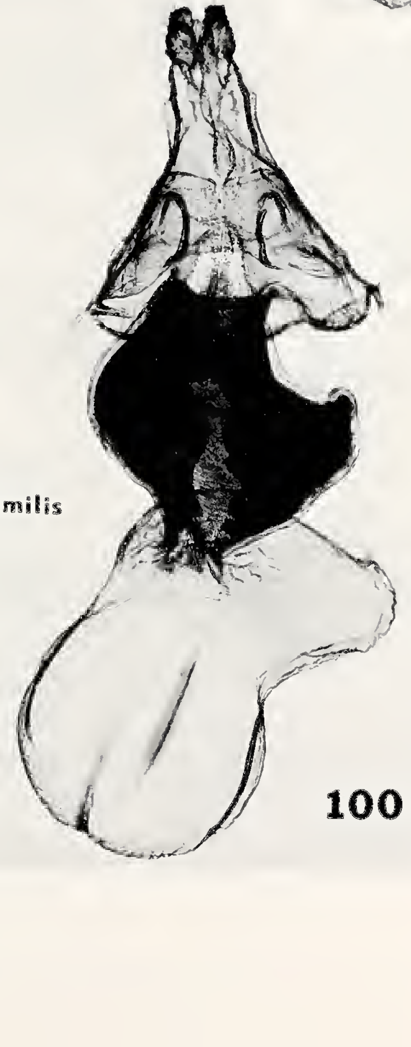
97 adjuncta



98 picta



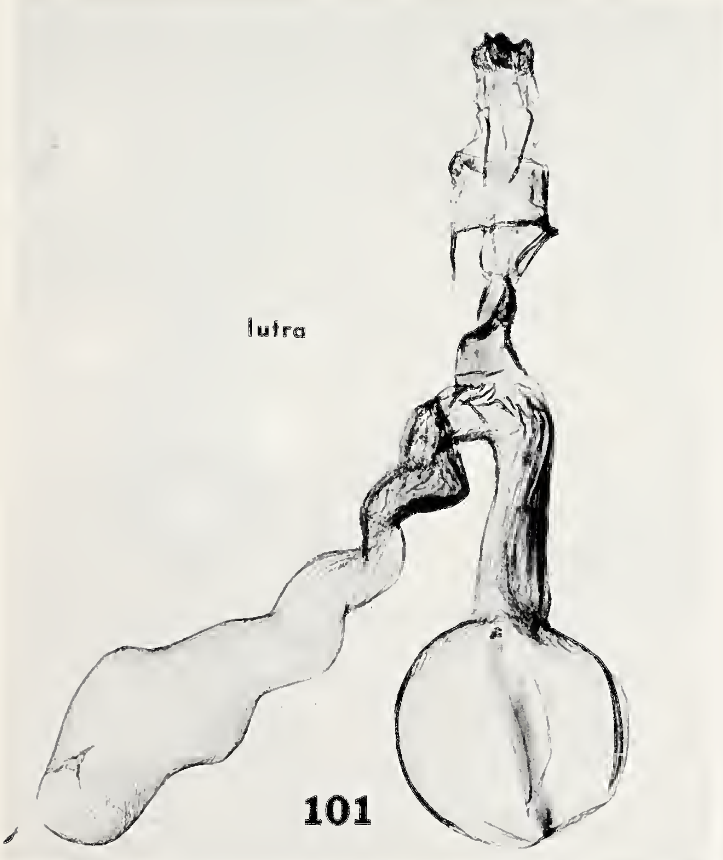
99 pulverulenta



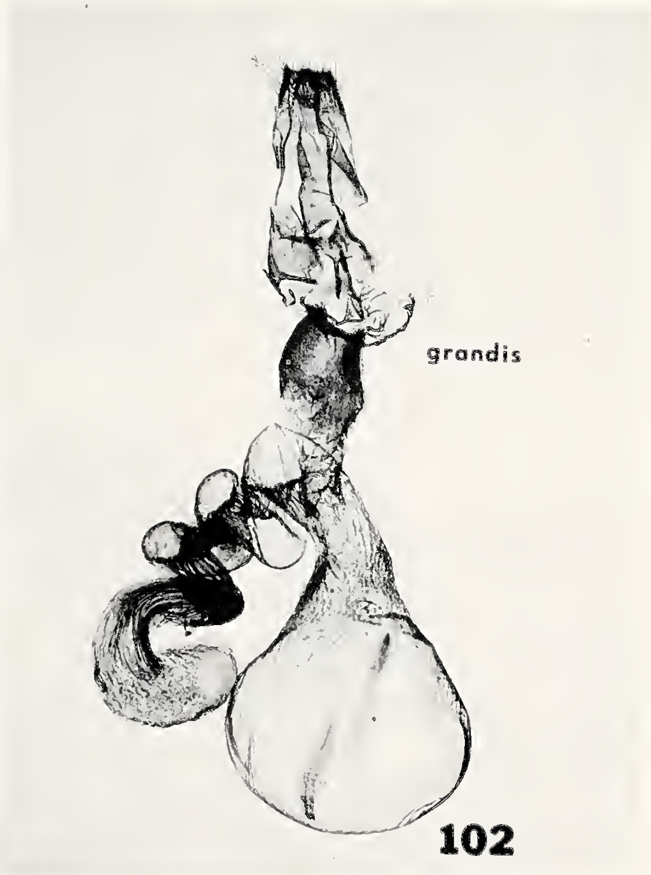
100 assimilis

FEMALE GENITALIA

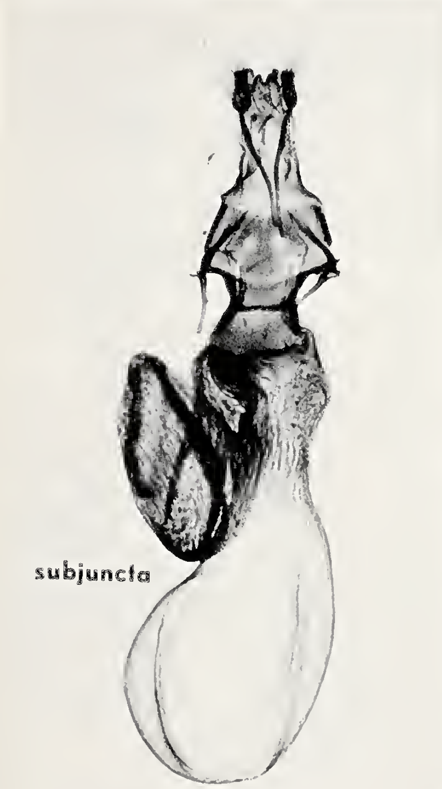
101 — *Spiramater lutra*, Lakehurst, New Jersey, slide no. 92 [JGF].
102 — *Spiramater grandis*, Horseheads, New York, slide no. 100 [JGF].
103 — *Lacanobia subjuncta*, Tompkins Co., New York, slide no. 63 [TLM].
104 — *Lacanobia nevadae*, Calgary, Alberta, slide no. 16 [USNM].
105 — *Lacanobia atlantica*, Tompkins Co., New York, slide no. 89 [JGF].



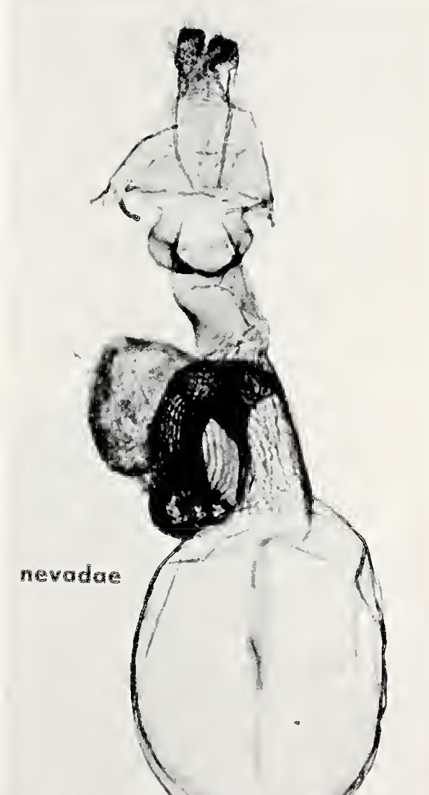
101



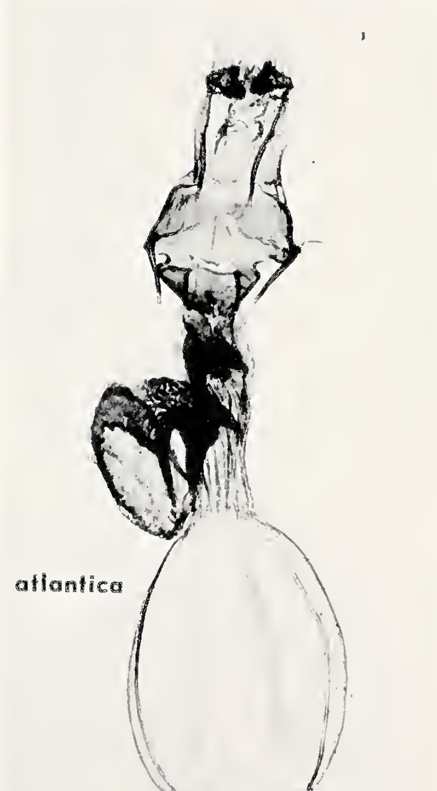
102



103



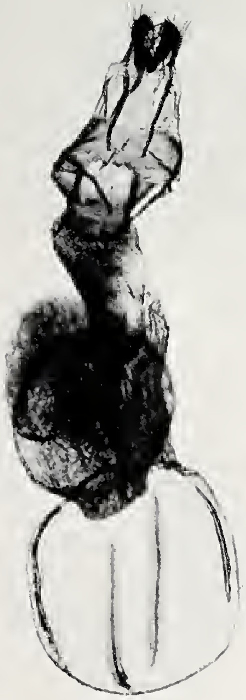
104



105

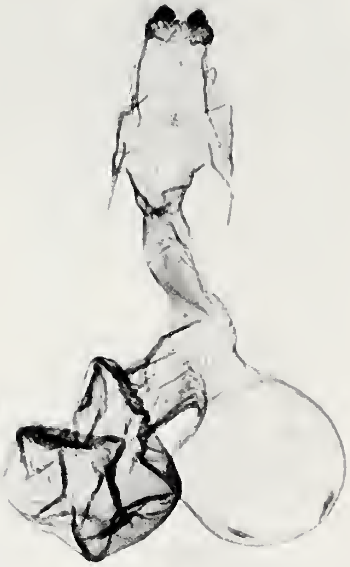
FEMALE GENITALIA

106 — *Lacanobia radix*, Linn Co., Oregon, slide no. 175 [TLM].
107 — *Trichordestra rugosa*, Mer Bleu [vic. Ottawa], Ontario, slide no. 96 [USNM].
108 — *Trichordestra tacoma*, Duncans, Vancouver Island, slide no. 18 [USNM].
109 — *Trichordestra legitima*, Albany Co., New York, slide no. 272 [TLM].
110 — *Trichordestra dodii*, Pitkin Co., Colorado, slide no. 240 [TLM].
111 — *Trichordestra beanii*, Florence, South Carolina, slide no. 126 [USNM].



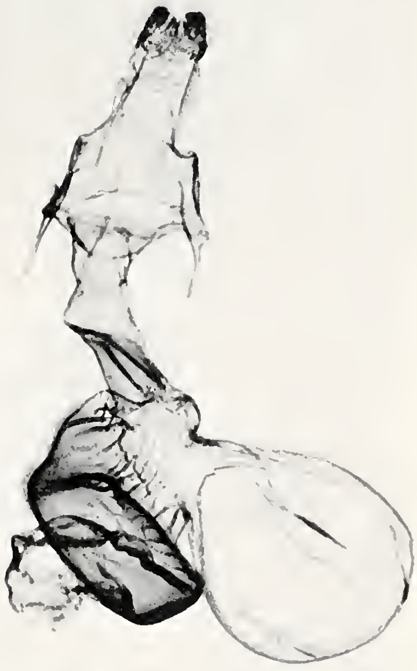
radix

106



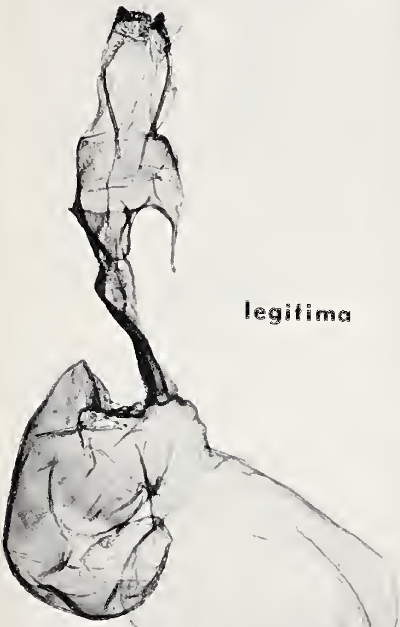
rugosa

107



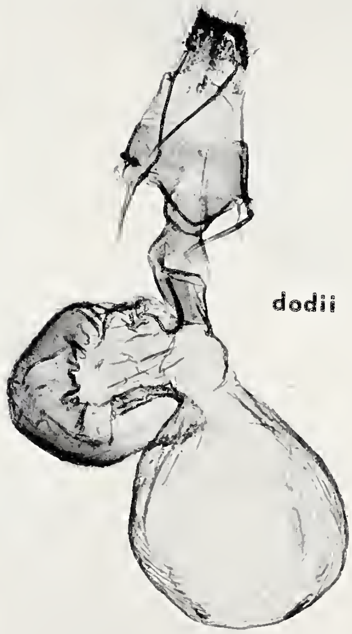
tacoma

108



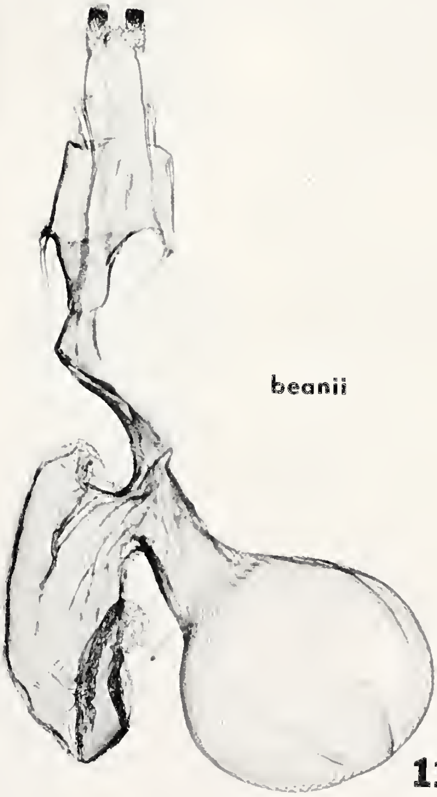
legitima

109



dodii

110

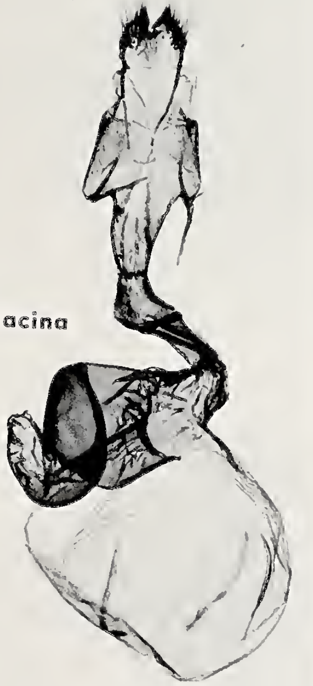


beanii

111

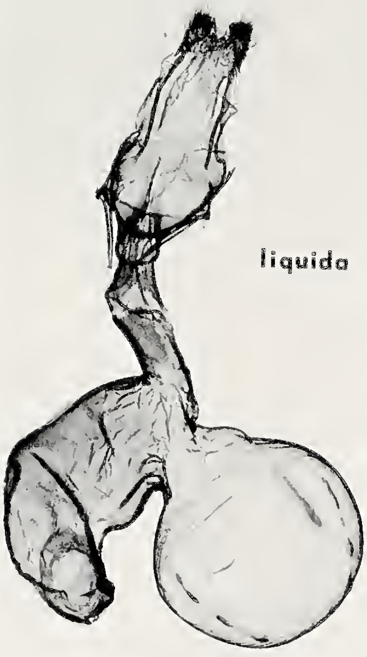
FEMALE GENITALIA

112 — *Trichordestra lilacina*, Conconino Co., Arizona, slide no. 244 [JGF].
113 — *Trichordestra liquida*, Banff, Alberta, slide no. 111 [USNM].
114 — *Trichordestra prodeniformis*, Cochise Co., Arizona, slide no. 58 [JGF].
115 — *Papestra quadrata*, Halifax Co., Nova Scotia, slide no. 266 [JGF].
116 — *Papestra biren*, Mt. Uniacke, Nova Scotia, slide no. 273 [USNM].
117 — *Papestra cristifera*, Banff, Alberta, slide no. 107 [USNM].
118 — *Papestra invalida*, Nevada Co., California, slide no. 288 [DAVIS].



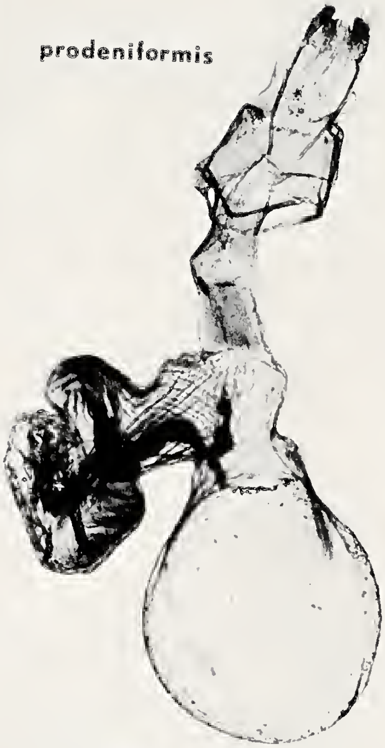
lilacina

112



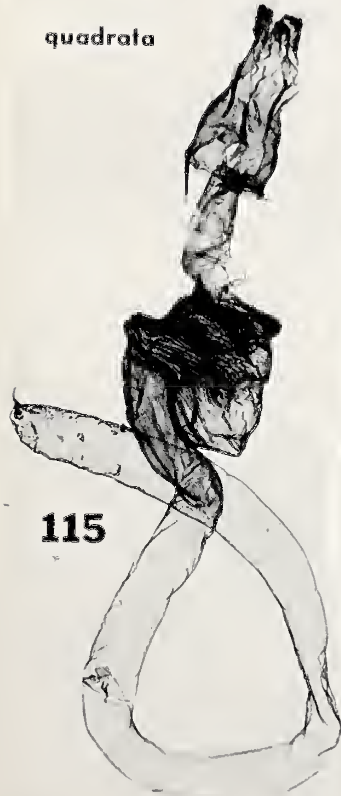
liquida

113



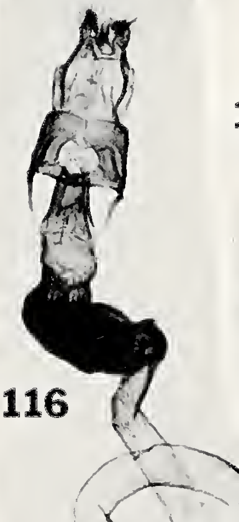
prodeniformis

114



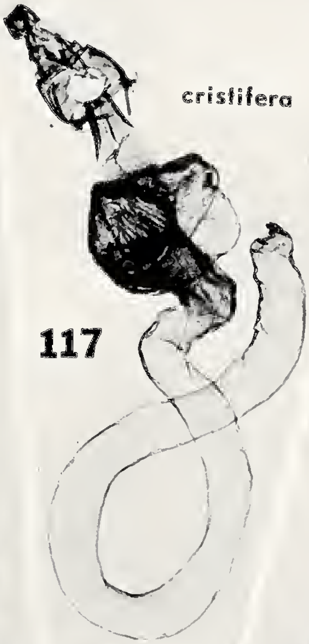
quadrata

115



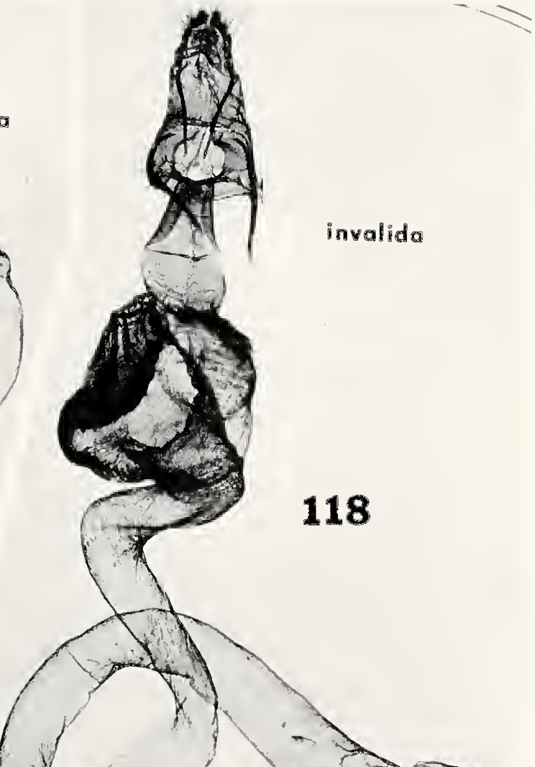
biren

116



cristifera

117

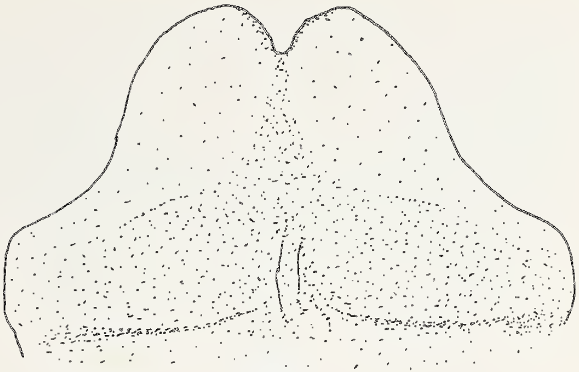


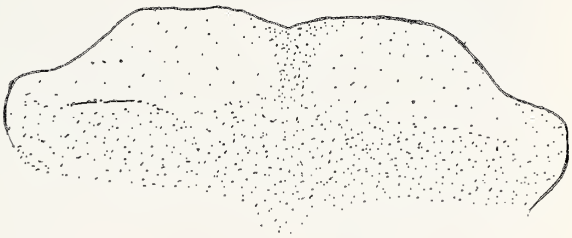
invalida

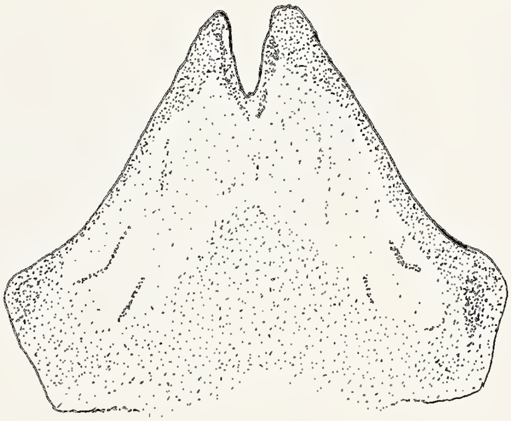
118

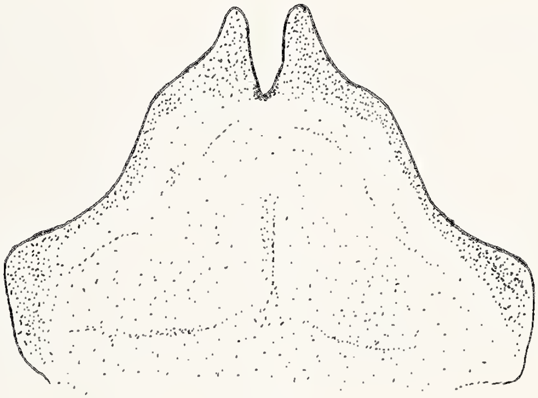
PAPESTRA FEMALE SEVENTH STERNITES AND *TRICHORDESTRA* JUXTA

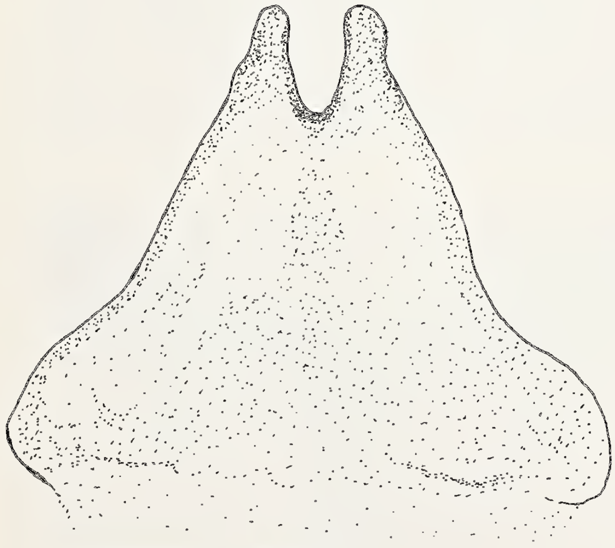
119 — *Papestra biren,* seventh sternite, Mt. Uniaeke, Nova Scotia, slide no. 273 [USNM].
120 — *Papestra quadrata,* seventh sternite, Garfield Co., Colorado, slide no. 253 [TLM].
121 — *Papestra brenda,* seventh sternite, Elko Co., Nevada, slide no. 295 [USNM].
122 — *Papestra cristifera,* seventh sternite, Idaho Co., Idaho, slide no. 294 [JGF].
123 — *Papestra invalida,* seventh sternite, Nevada Co., California, slide no. 288 [DAVIS].
124 — *Trichordestra legitima,* juxta, Ithaca, New York, JGF slide no. 2151 [JGF].
125 — *Trichordestra dodii,* juxta, Gothic, Colorado, JGF slide no. 4969 [JGF].

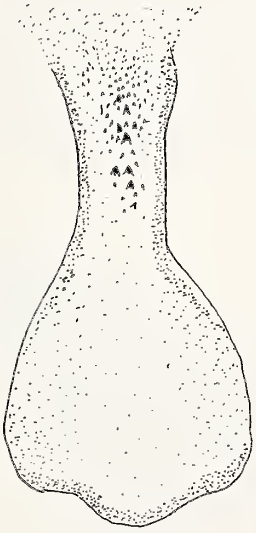

biren **119**

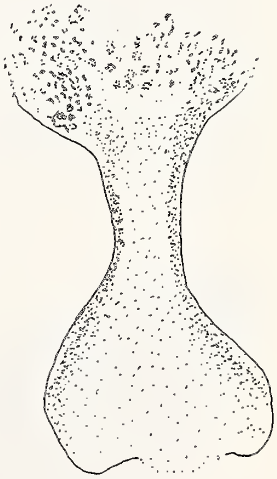

quadrata **120**


brenda **121**


cristifera **122**

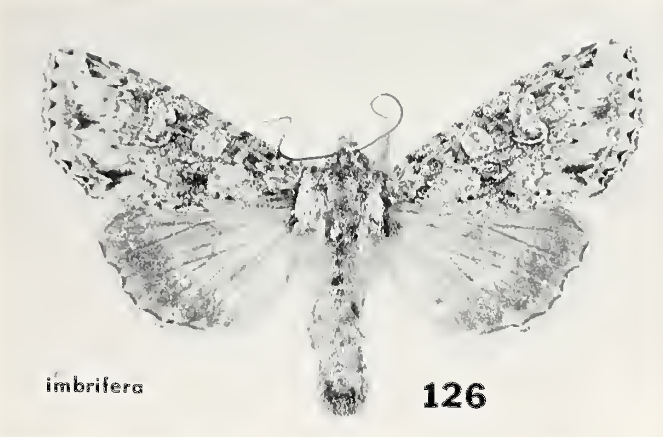

invalida **123**


legitima **124**

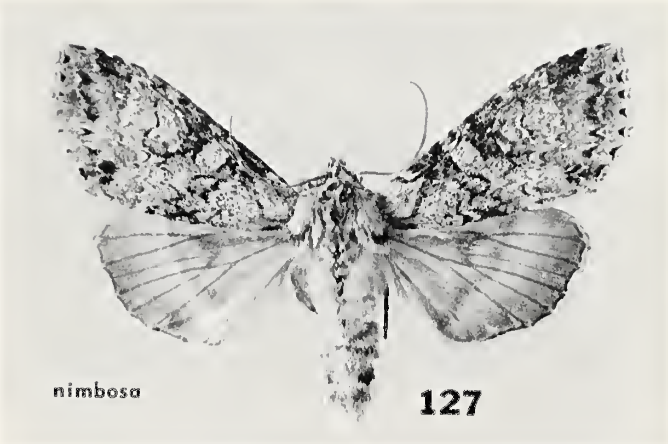

dodii **125**

ADULTS

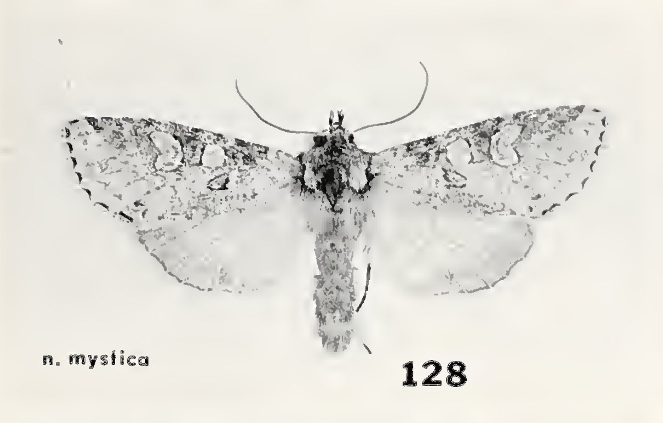
126 — *Polia imbrifera,* Tompkins, Co., New York [TLM].
127 — *Polia nimbosa,* Albany Co., New York [TLM].
128 — *Polia nimbosa,* subspecies *mystica,* Calgary, Alberta [USNM].
129 — *Polia nimbosa,* subspecies *mysticoides,* Duncans, Vancouver Island [USNM].
130 — *Polia piniae,* Idaho Co., Idaho [TLM].
131 — *Polia discalis,* Teton Co., Montana [TLM].
132 — *Polia discalis,* Black Hills, South Dakota [USNM].
133 — *Polia rogenhoferi* form *carbonifera,* Estes Park, Colorado [CNC].



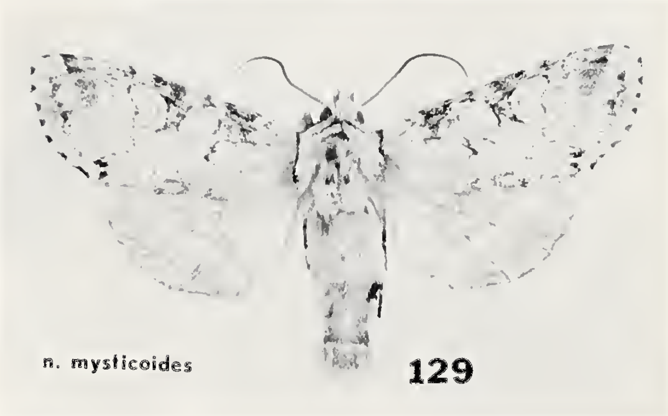
imbrifera **126**



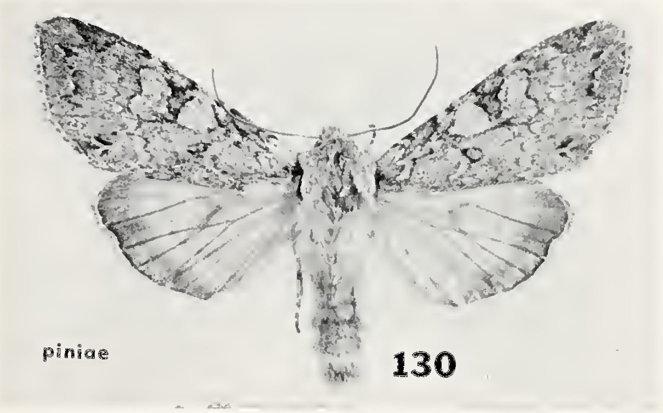
nimbosa **127**



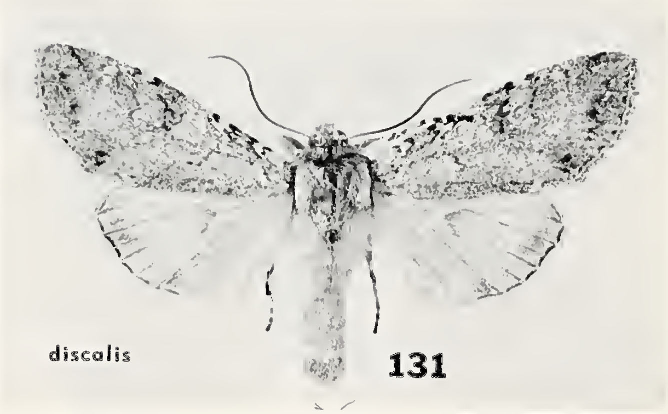
n. mystica **128**



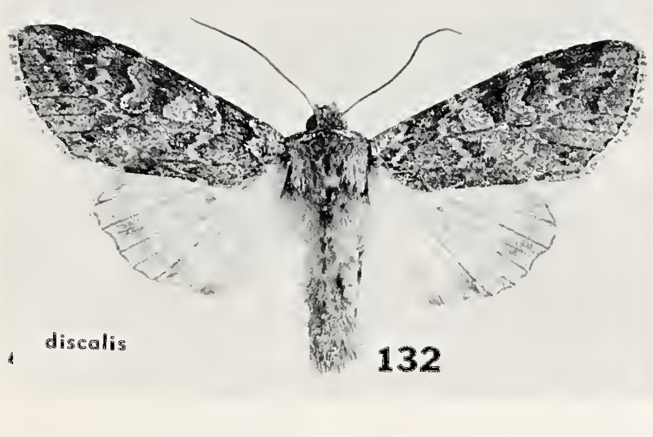
n. mysticoides **129**



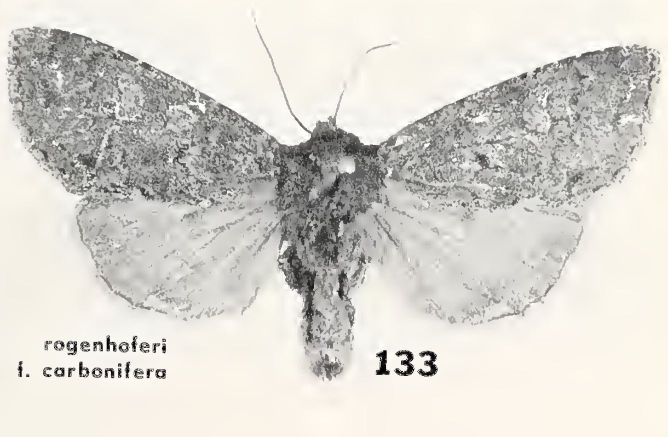
piniae **130**



discalis **131**



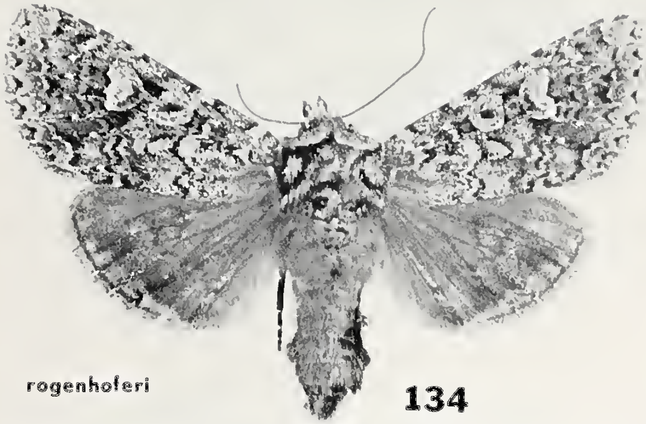
discalis **132**



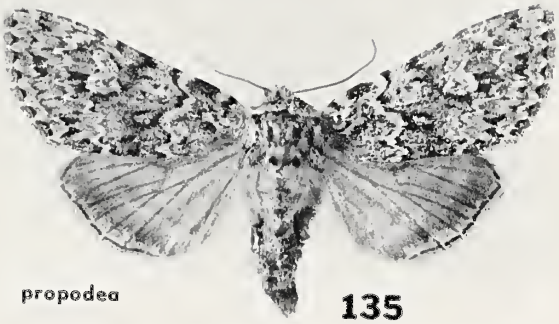
rogenhoferi
f. carbonifera **133**

ADULTS

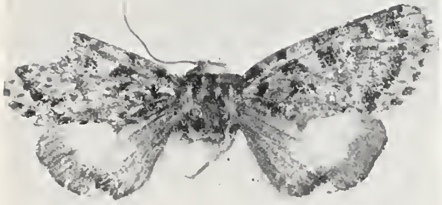
134 — *Polia rogenhoferi*, Doyles, Codroy Valley, Newfoundland [USNM].
135 — *Polia propodea*, Doyles, Codroy Valley, Newfoundland [USNM].
136 — *Polia richardsoni*, subspecies *magna*, TYPE, Bullion Peak, Colorado, 13,000′ [USNM].
137 — *Polia richardsoni*, Nain, Labrador [USNM].
138 — *Polia nugatis*, Sweet Grass Co., Montana [JGF].
139 — *Polia purpurissata*, "*languida*" TYPE, slightly reduced, Colorado, Bruee No. 261 [USNM].
140 — *Polia purpurissata*, Slope Co., North Dakota [TLM].
141 — *Polia purpurissata*, "*crydina*," Shoshone Co., Idaho [TLM].
142 — *Polia purpurissata*, subspecies *apurpura*, Coconino Co., Arizona [JGF].



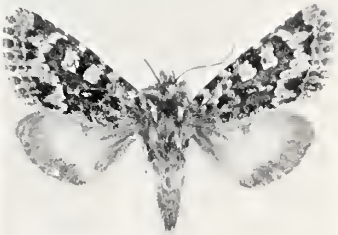
rogenhoferi **134**



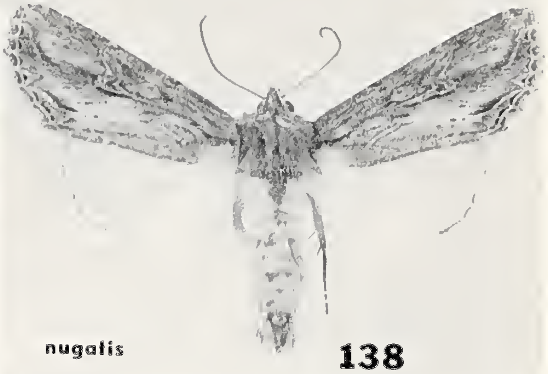
propodea **135**



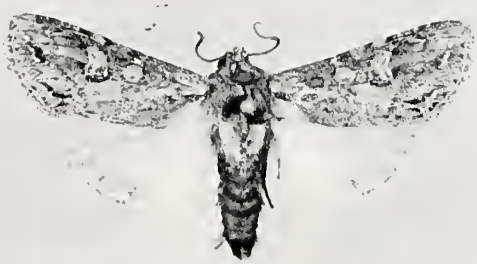
r. magna
TYPE **136**



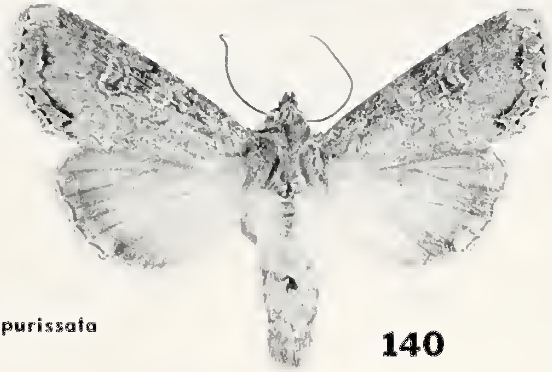
richardsoni **137**



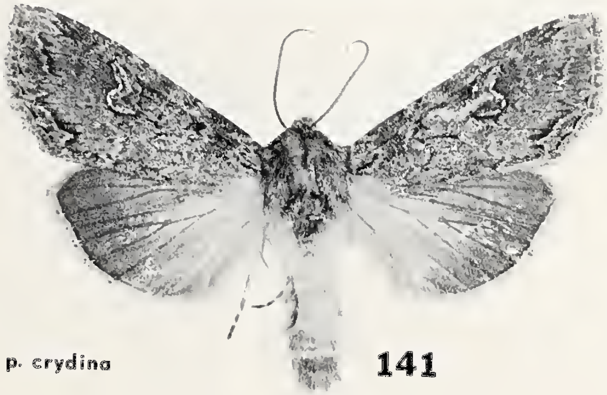
nugatis **138**



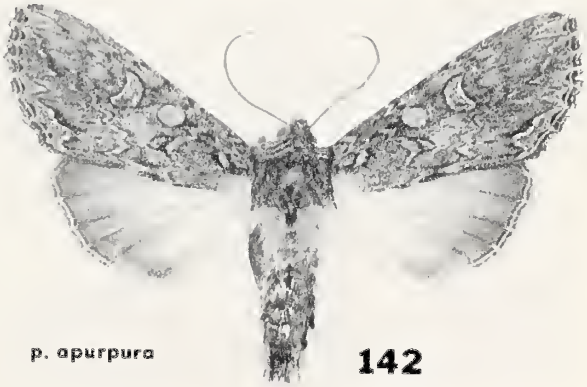
purpurissata
(languida TYPE) **139**



purpurissata **140**



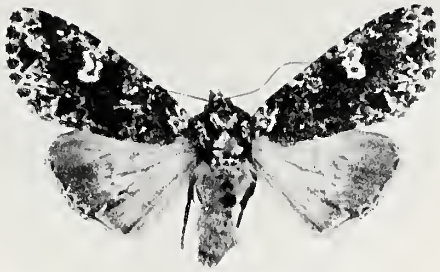
p. crydina **141**



p. apurpura **142**

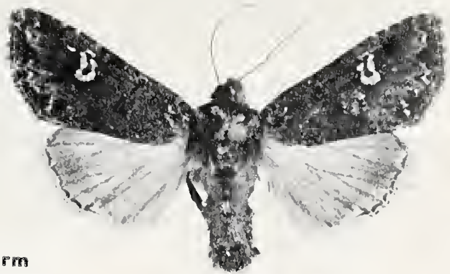
ADULTS

143 — *Melanchra adjuncta*, Tompkins Co., New York [TLM].
144 — *Melanchra adjuncta*, melanic form *benjamini*, Tompkins Co., New York [TLM].
145 — *Melanchra picta*, Ransom Co., North Dakota [TLM].
146 — *Melanchra pulverulenta*, Dieringer, Washington [USNM].
147 — *Melanchra assimilis*, Calgary, Alberta [USNM].
148 — *Spiramater grandis*, Tompkins Co., New York [TLM].
149 — *Spiramater lutra*, Chenango Co., New York [TLM].
150 — *Lacanobia subjuncta*, Tompkins Co., New York [TLM].



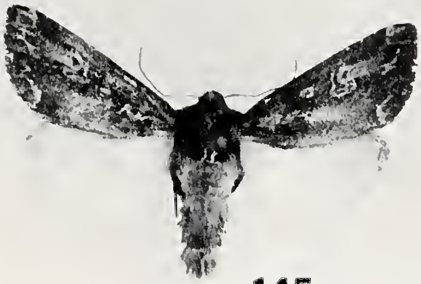
adjuncta

143



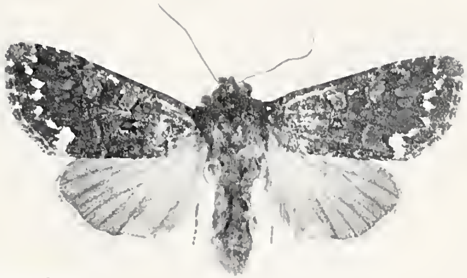
form
benjamini

144



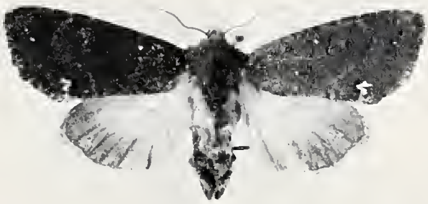
picta

145



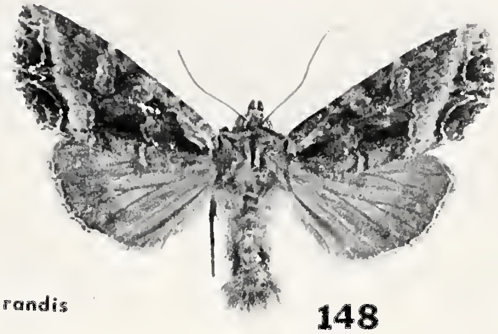
pulverulenta

146



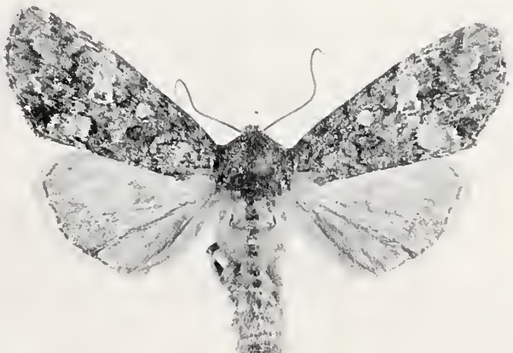
assimilis

147



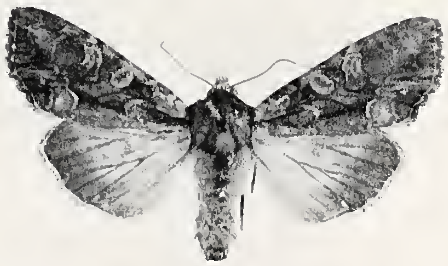
grandis

148



lutra

149

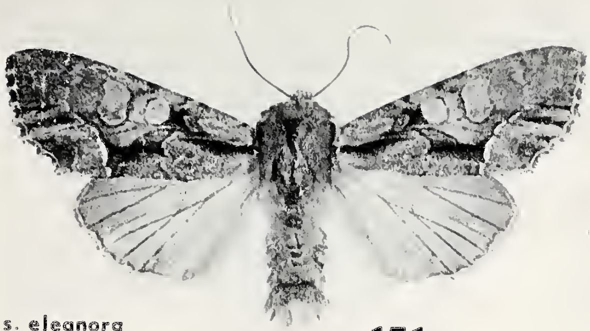


subjuncta

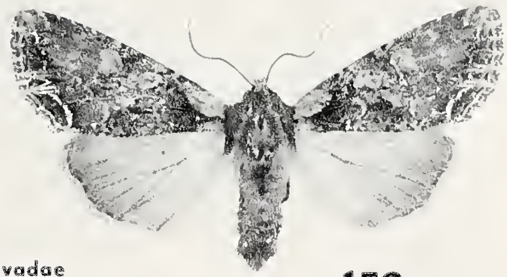
150

ADULTS

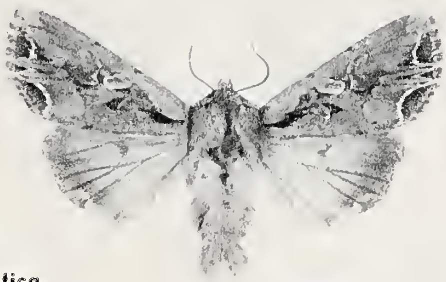
151 — *Lacanobia subjuncta*, subspecies *eleanora*, Johnsville, California [USNM].
152 — *Lacanobia nevadae*, Pitkin Co., Colorado [TLM].
153 — *Lacanobia atlantica*, Tompkins Co., New York [JGF].
154 — *Lacanobia radix*, Riding Mts., Manitoba [JGF].
155 — *Trichordestra rugosa*, Oneida Co., Wisconsin [LACM].
156 — *Trichordestra tacoma*, Dalvay House, Canadian National Park [CNC].
157 — *Trichordestra legitima*, Tompkins Co., New York [TLM].
158 — *Trichordestra dodii*, Calgary, Alberta [USNM].



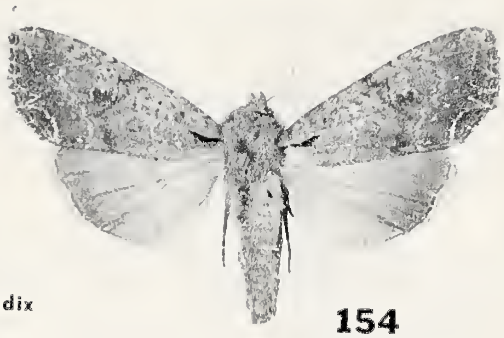
s. eleanora **151**



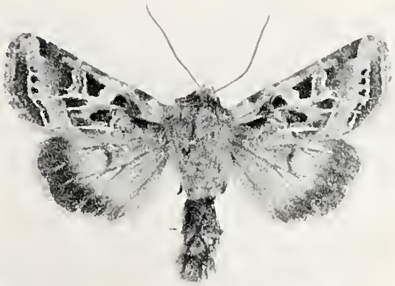
nevadae **152**



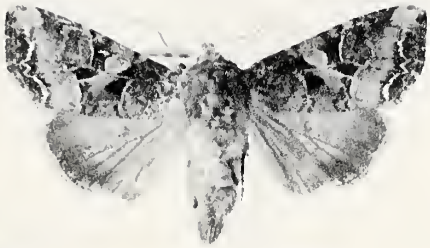
atlantica **153**



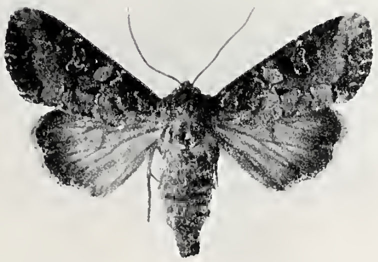
radix **154**



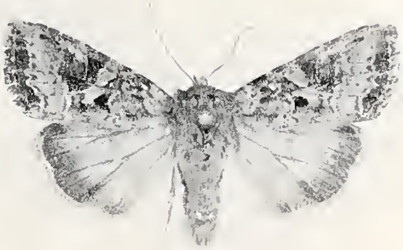
rugosa **155**



tacoma **156**



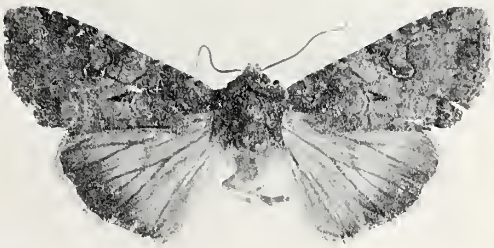
legitima **157**



dodii **158**

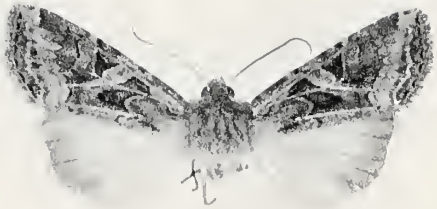
ADULTS

159 — *Trichordestra beanii*, Highlands, North Carolina [CNC].
160 — *Trichordestra lilacina*, subspecies *luski*, Coconino Co., Arizona [JGF].
161 — *Trichordestra lilacina*, form *illebefacta*, Slope Co., North Dakota [TLM].
162 — *Trichordestra liquida*, Bozeman, Montana [CNC].
163 — *Trichordestra liquida*, Oreas Island, Washington [USNM].
164 — *Trichordestra prodeniformis*, Cochise Co., Arizona [TLM].
165 — *Papestra quadrata*, subspecies *ingravis*, Big Indian Lake, Nova Scotia [USNM].
166 — *Papestra quadrata*, Balsam Lake, British Columbia [CNC].



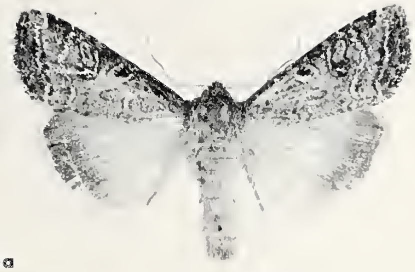
beanii

159



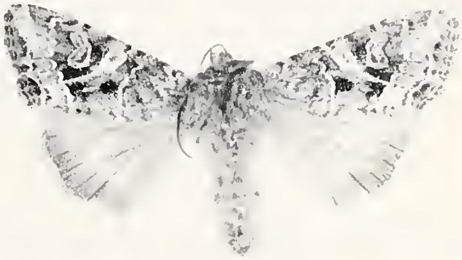
lilacina

160



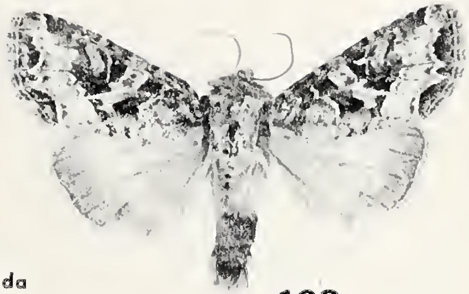
lilacina
f. illebefacta

161



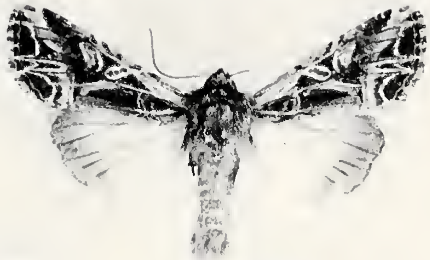
liquida

162



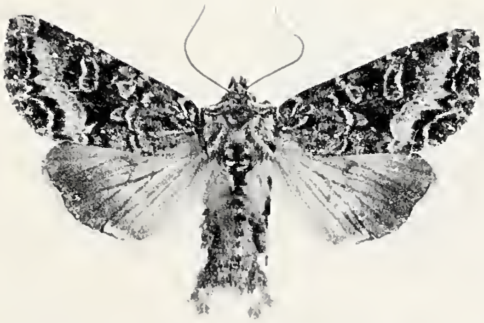
liquida

163



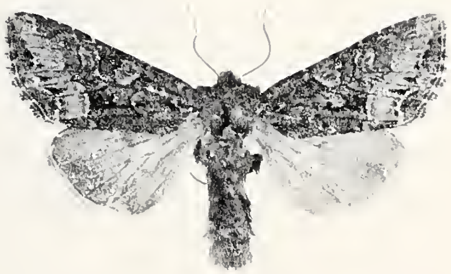
prodeniformis

164



q. ingravis

165

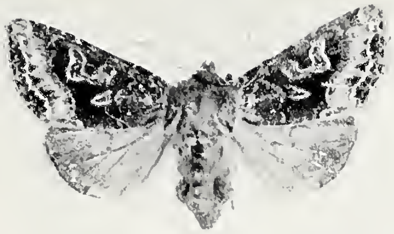


quadrata

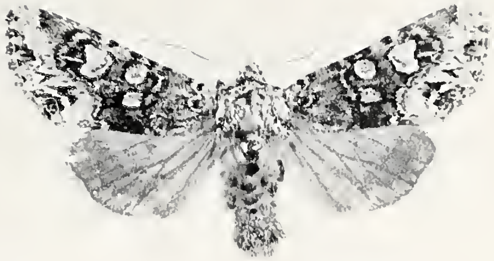
166

ADULTS

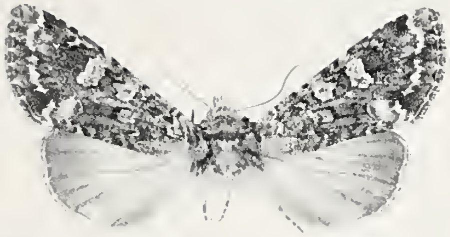
167 — *Papestra quadrata*, 10 mi. E. Kenai Peninsula, Alaska [CNC].
168 — *Papestra biren*, Big Indian Lake, Nova Scotia [USNM].
169 — *Papestra cristifera*, Idaho Co., Idaho [TLM].
170 — *Papestra brenda*, Angel Lake, Nevada [USNM].
171 — *Papestra brenda*, Stockton, Utah [USNM].
172 — *Papestra brenda*, Nevada Co., California [LACM].
173 — *Papestra invalida*, Plumas Co., California [RHL].



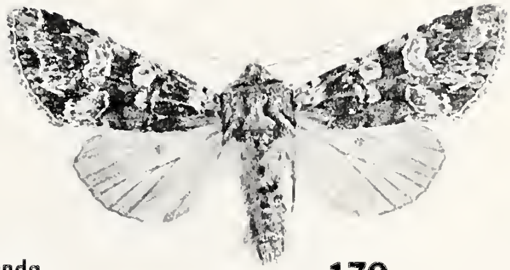
quadrata 167



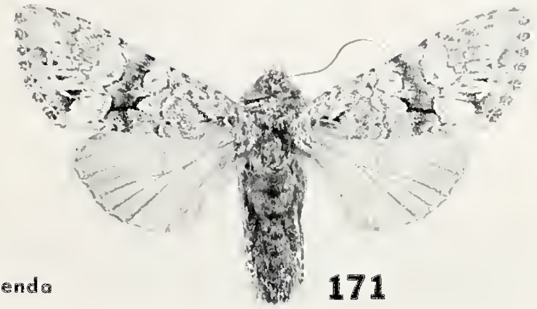
biren 168



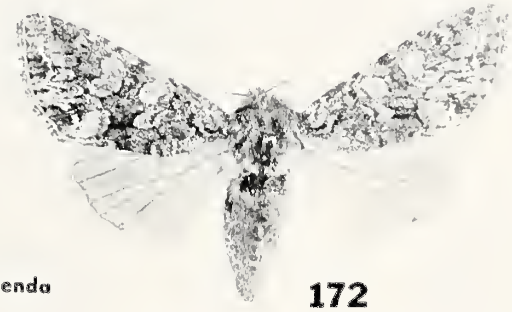
cristifera 169



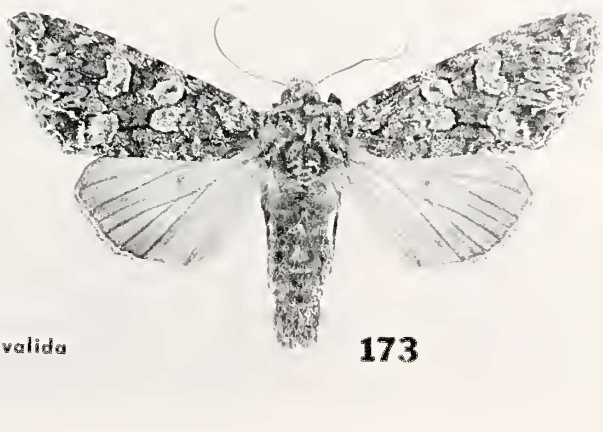
brenda 170



brenda 171



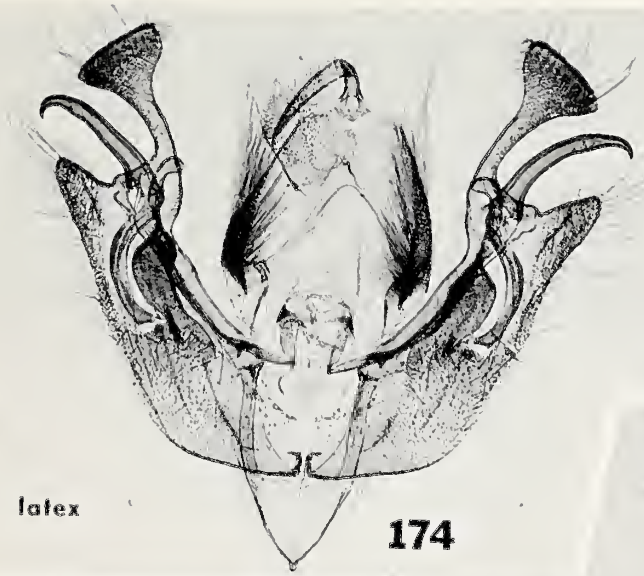
brenda 172



invalida 173

MALE GENITALIA

174 — "*Polia*" *latex*, valves, Essex Co., Vermont, slide no. 68 [TLM].
175 — "*Polia*" *latex*, aedeagus with vesica everted, same data [TLM].
176 — "*Polia*" *purpurea*, TYPE, valves, Palmerlee, Arizona, USNM slide no. 1938 [USNM].
177 — "*Polia*" *purpurea*, TYPE, aedeagus with vesiea everted, same data [USNM].
178 — "*Polia*" *segregata*, valves, Banff, Alberta, slide no. 140 [CNC].
179 — "*Polia*" *segregata*, aedeagus with vesica everted, same data [CNC].



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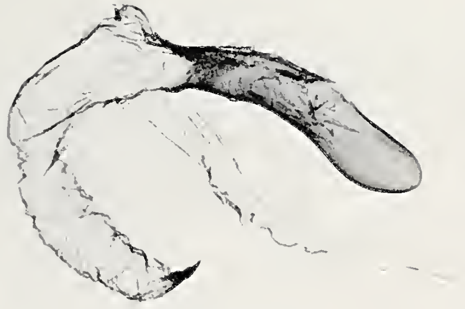

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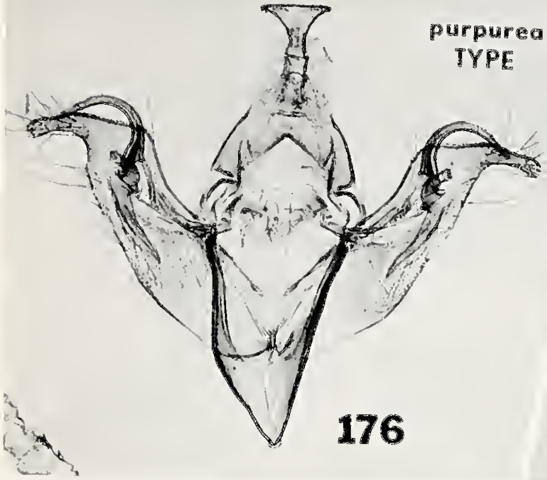

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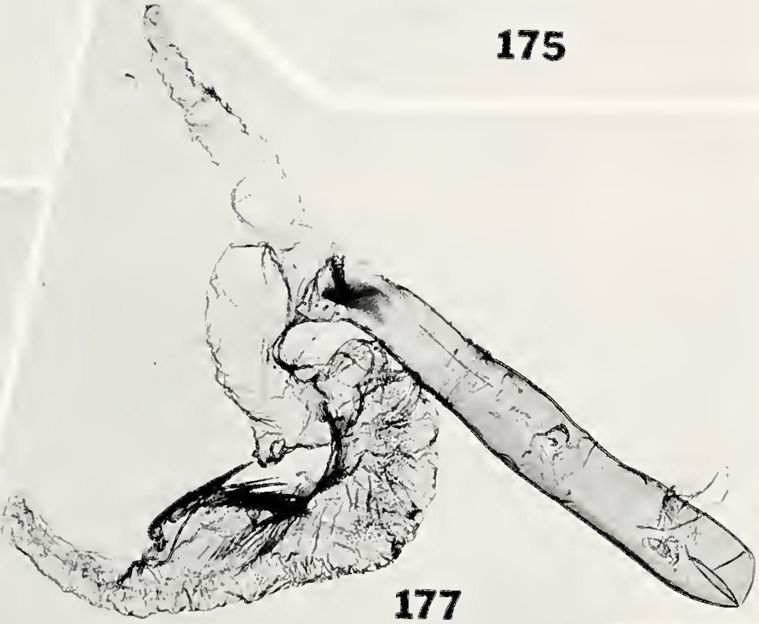

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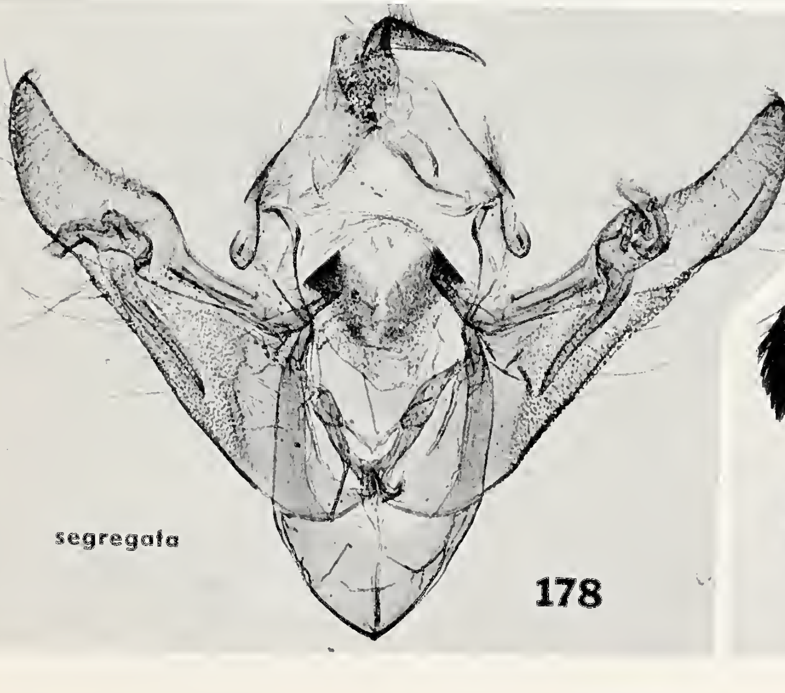

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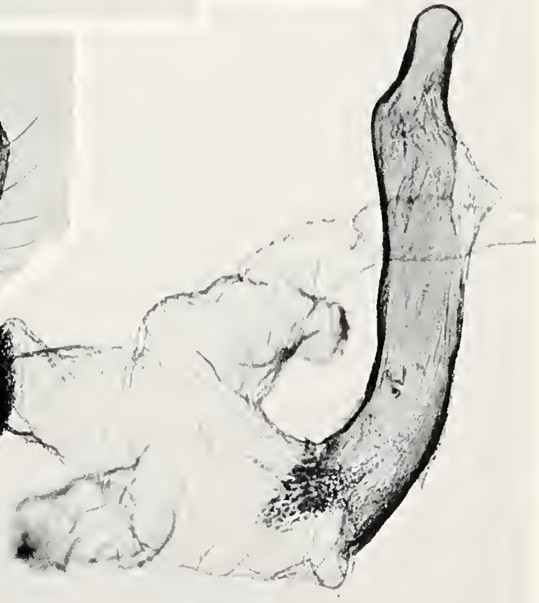

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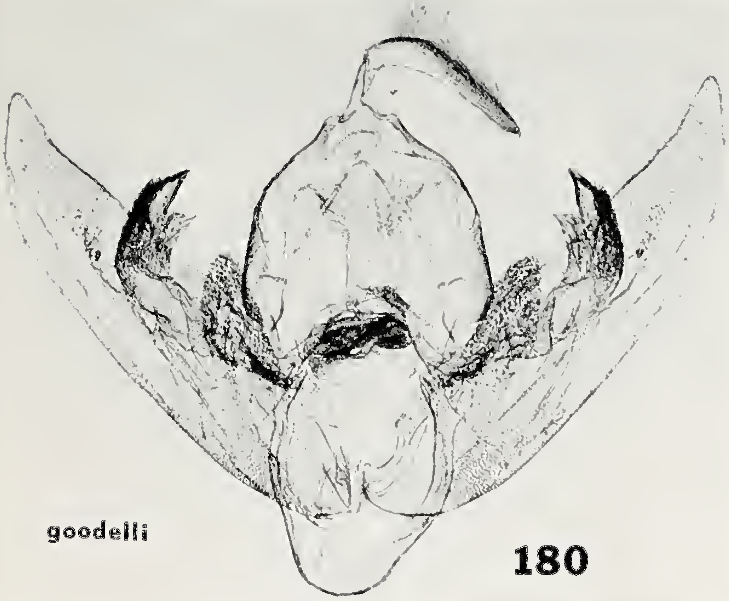
MALE GENITALIA

180 — "*Polia*" *goodelli*, valves, Tompkins Co., New York, slide no. 4 [TLM].
181 — "*Polia*" *goodelli*, aedeagus with vesica everted, same data [TLM].
182 — "*Polia*" *obscura*, aedeagus with vesica everted, Clay Co., Minnesota, slide no. 22 [TLM].
183 — "*Polia*" *obscura*, valves, same data [TLM].
184 — "*Polia*" *nipana*, valves, Mader Canyon, Arizona, slide no. 291 [JGF].
185 — "*Polia*" *nipana*, aedeagus with vesica everted, same data [JGF].



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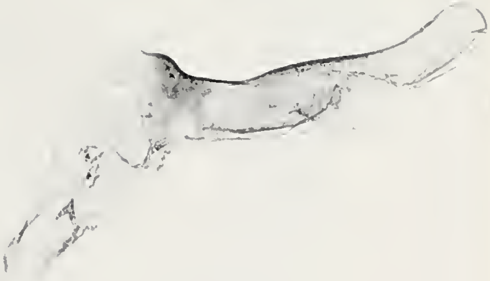

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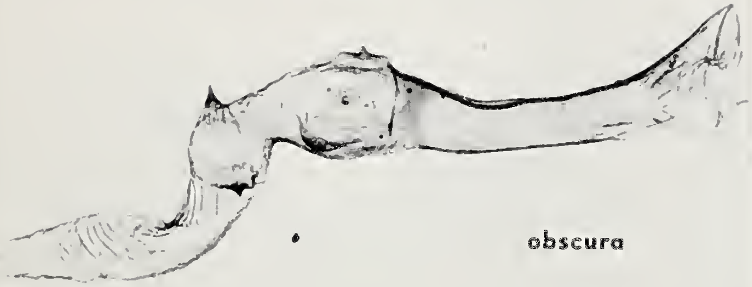

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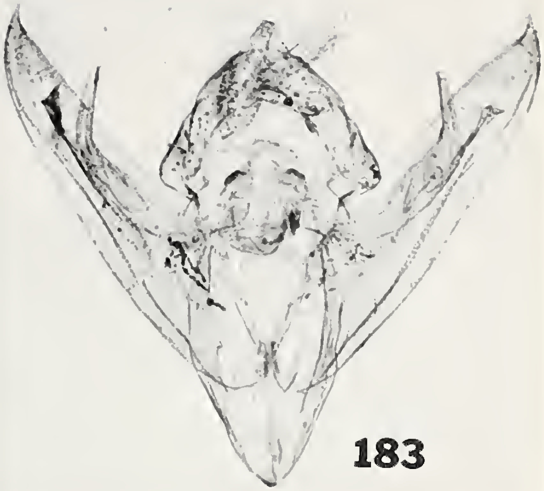

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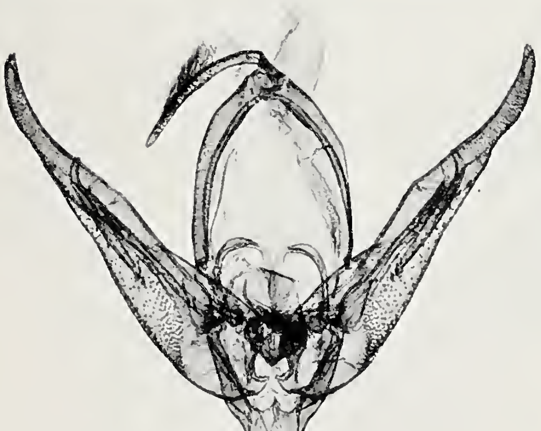

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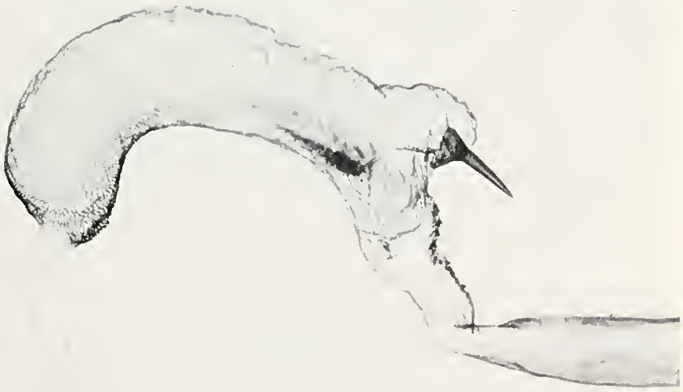
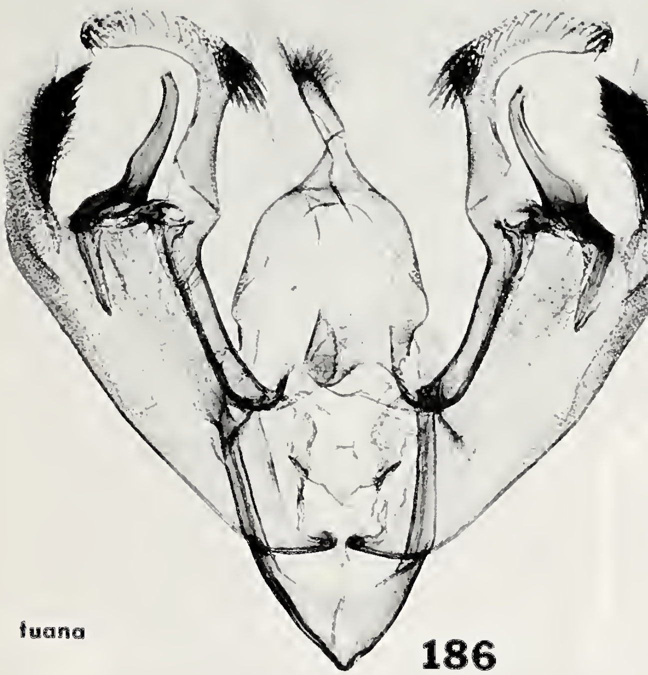


185

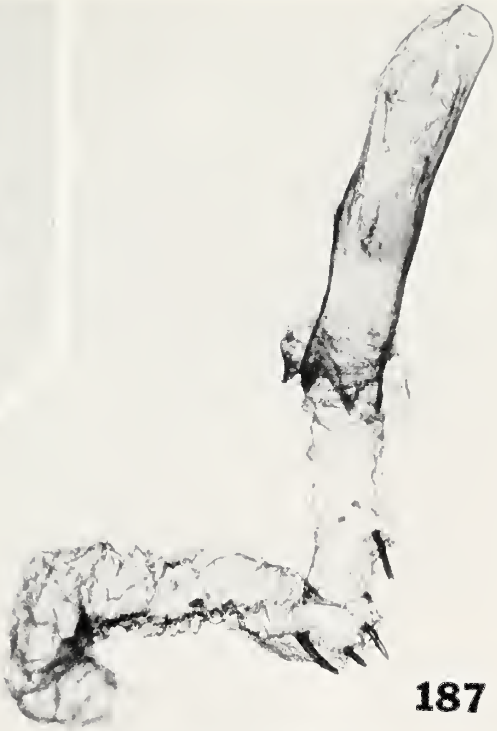
MALE GENITALIA

186 — "*Polia*" *tuana*, valves, Cochise Co., Arizona, slide no. 285 [TLM].
187 — "*Polia*" *tuana*, aedeagus with vesica everted, same data [TLM].
188 — "*Polia*" *noverca*, aedeagus with vesica everted, Gilliam Co., Oregon, slide no. 212 [TLM].
189 — "*Polia*" *noverca*, valves, same data [TLM].
190 — "*Polia*" *detracta*, valves, Tompkins Co., New York, slide no. 46 [TLM].
191 — "*Polia*" *detracta*, aedeagus with vesica everted, same data [TLM].



fuana

186



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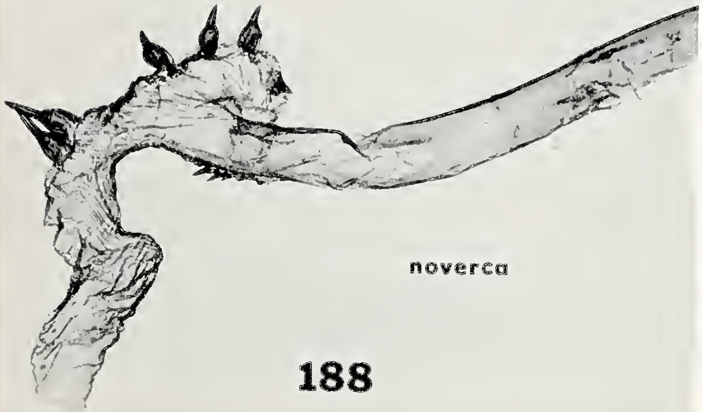
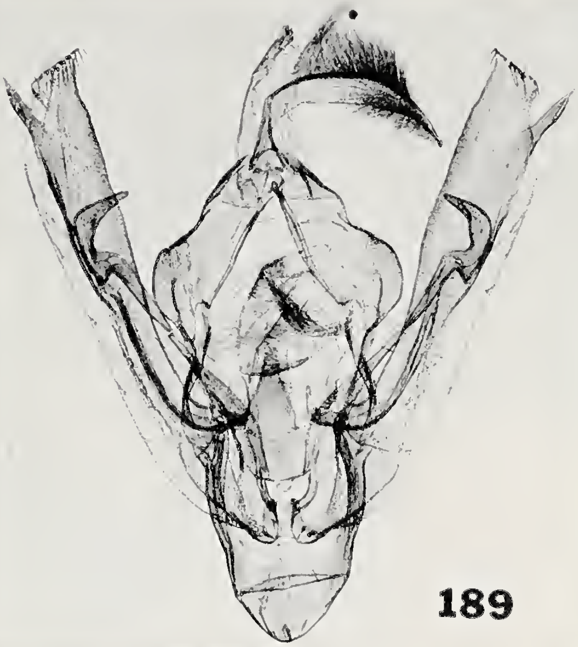


noverca

188



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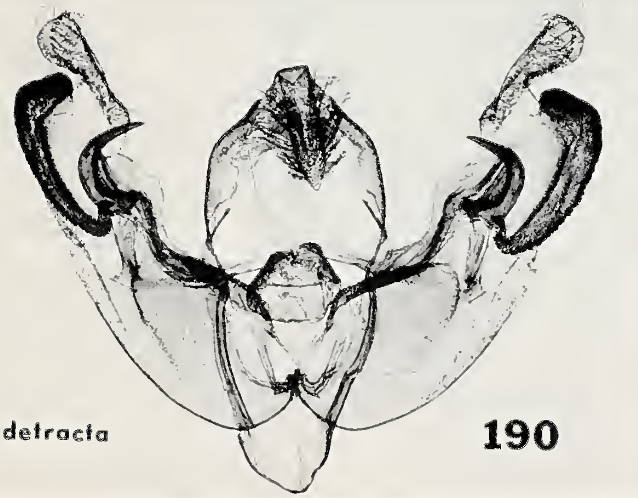

detracta

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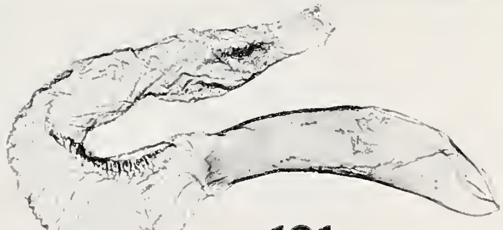

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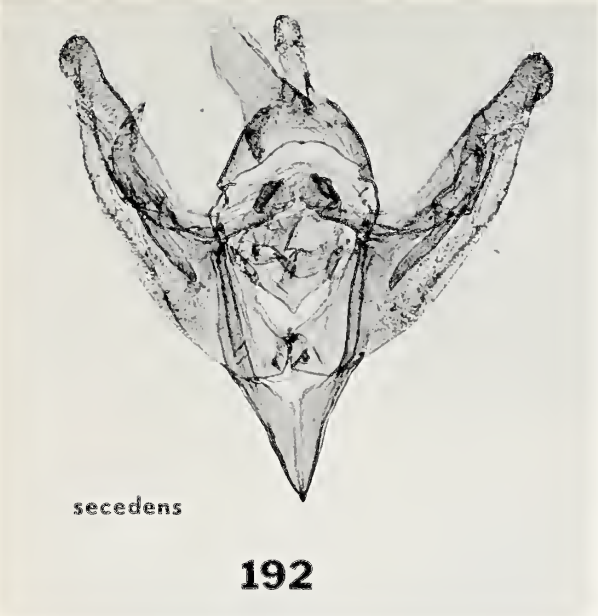
MALE GENITALIA AND ABDOMINAL SCLERITES

192 — "*Polia*" *secedens*, valves, Banff, Alberta, slide no. 150 [USNM].
193 — "*Polia*" *secedens*, aedeagus with vesica everted, same data [USNM].
194 — "*Polia*" *basivirida*, TYPE, aedeagus with vesica everted, Tuscon, Arizona, USNM slide on. 1969 [USNM].
195 — "*Polia*" *basivirida*, TYPE, valves, same data [USNM].
196 — *Trichordestra lilacina*, ♂ abdominal sclerites, slide no. 164 [TLM].
cti, coremata; p, pocket; lv, lever; br, brush.



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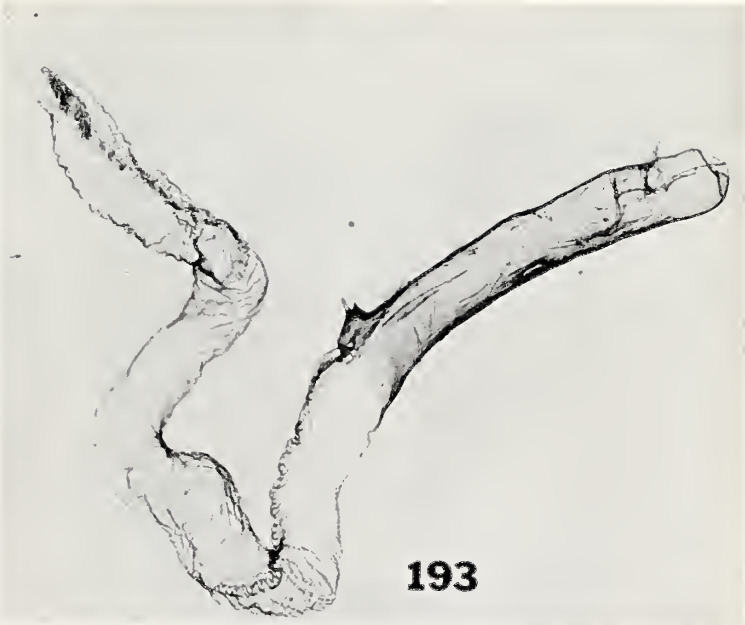

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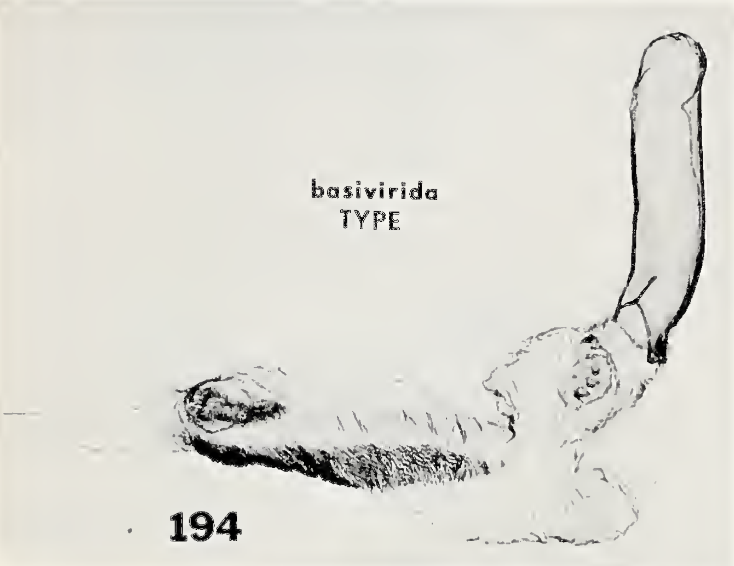

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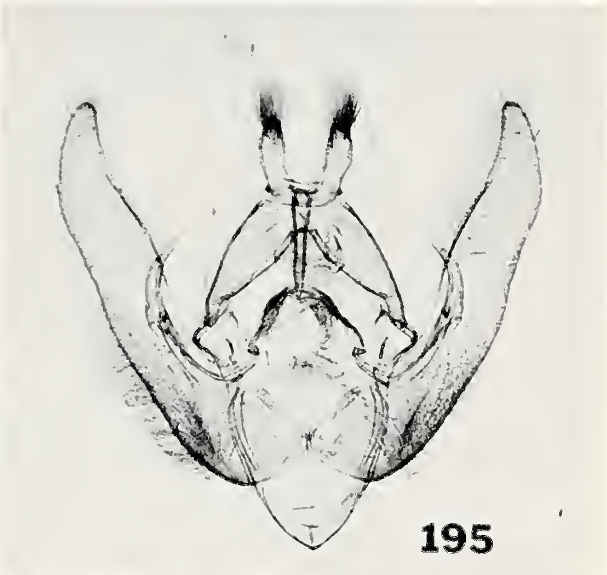

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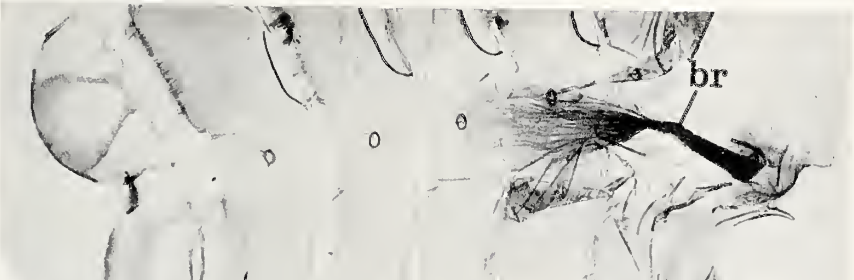
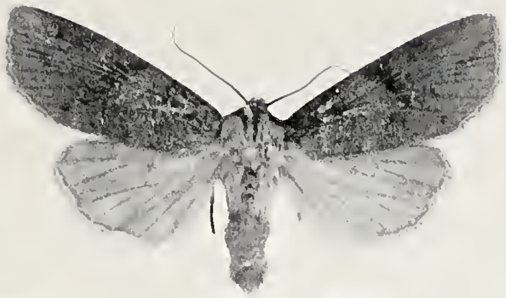


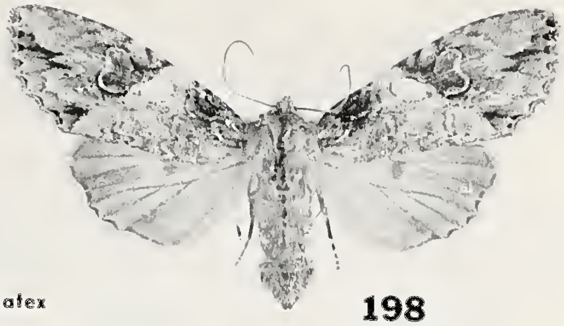
196

ADULTS

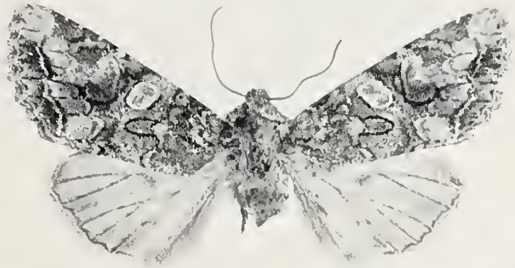
197 — "*Polia*" *latex,* melanic, Essex Co., Vermont [TLM].
198 — "*Polia*" *latex,* Tompkins Co., New York [TLM].
199 — "*Polia*" *purpurea,* Redington, Arizona [USNM].
200 — "*Polia*" *segregata,* Harlan, Saskatchewan [CNC].
201 — "*Polia*" *goodelli,* Essex Co., Vermont [TLM].
202 — "*Polia*" *obscura,* Clay Co., Minnesota [TLM].
203 — "*Polia*" *nipana,* male, Santa Cruz Co., Arizona [JGF].
204 — "*Polia*" *nipana,* female, Santa Cruz Co., Arizona [JGF].



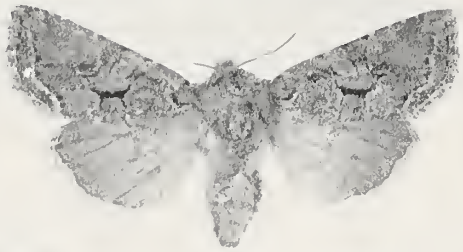
latex **197**



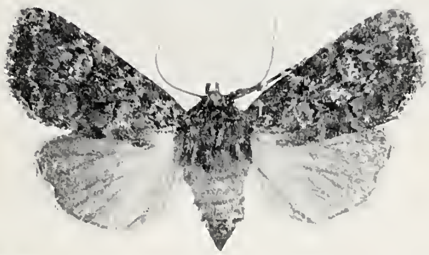
latex **198**



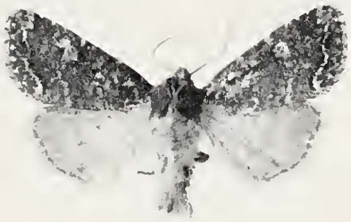
purpurea **199**



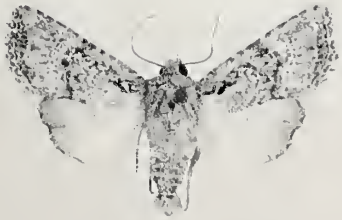
segregata **200**



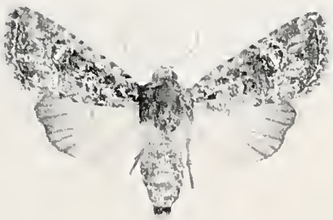
goodelli **201**



obscura **202**



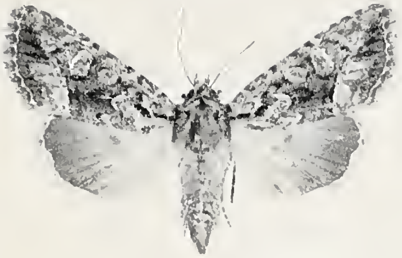
nipana **203**



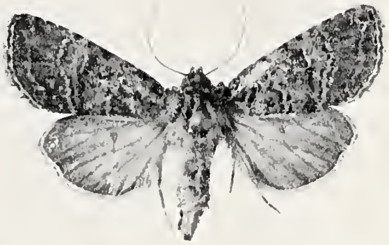
nipana **204**

ADULTS

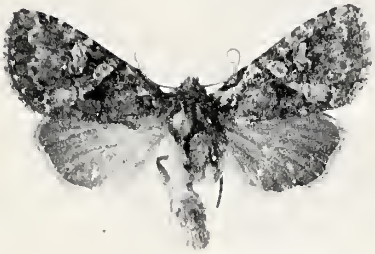
205 — "*Polia*" *tuana*, Santa Cruz Co., Arizona [JGF].
206 — "*Polia*" *noverca*, Gilliam Co., Oregon [TLM].
207 — "*Polia*" *detracta*, Tompkins Co., New York [TLM].
208 — "*Polia*" *secedens*, Banff, Alberta [USNM].
209 — "*Polia*" *basivirida*, Cochise Co., Arizona [JGF].
210 — *Graphania mutans*, "*passa*" TYPE, erroneously labeled "Cal." (specimen is actually from New Zealand) [MSU].



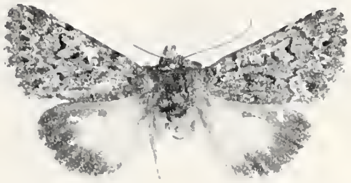
tuana **205**



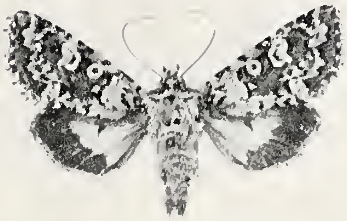
noverca **206**



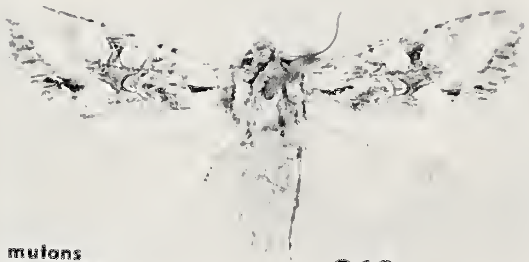
detracta **207**



secedens **208**



basivirida **209**



mutans
(passa TYPE) **210**

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